

Bulletin Board

Contents

MAR. 03, 2023

(click on page numbers for links)

REGULATORY UPDATE

ASIA PACIFIC

Proposal P1059 - Energy labelling on alcoholic beverages	4
Mumbai's air quality worst in February in four years.....	4
Proposal P1010 – Review of Formulated Supplementary Sports Foods.....	5
APVMA Gazette No. 4, 21 February 2023	5
Proposal P1061- Code Maintenance Proposal 2023.....	6
Application A1227 Alpha-arabinofuranosidase from GM Trichoderma reesei as a processing aid	6
Application A1228 Endo-1,4-beta-xylanase from GM Trichoderma reesei (gene donor: Talaromyces leycettanus) as a processing aid.....	6
Application A1229 Carboxypeptidase from GM Aspergillus oryzae as a processing aid.....	7

AMERICA

Would better regulations and equipment mandates have prevented the Ohio rail disaster?	7
Water Utilities Brace for Imminent EPA Proposal on PFAS in Water	8
The race to waterproof outdoor gear — without toxic chemicals.....	10
Biden administration restores Obama-era mercury rules for power plants, eyes more regulations in coming months.....	10
Water Utilities Brace for Imminent EPA Proposal on PFAS in Water	11
EPA Updates TSCA Inventory, Plans Next Update in Summer 2023.....	12

EUROPE

HSE publishes restriction opinion on tattoo and permanent make- up inks	13
Are the EU's proposed new packaging regulations fit for purpose?	14

REACH UPDATE

'Game over' for EU's REACH chemical safety review, campaigners say.....	16
---	----

JANET'S CORNER

Hydrogen Isotopes	18
-------------------------	----

CONTACT US

subscribers@chemwatch.
net
tel +61 3 9572 4700
fax +61 3 9572 4777

1227 Glen Huntly Rd
Glen Huntly
Victoria 3163 Australia

*** While Chemwatch has taken all efforts to ensure the accuracy of information in this publication, it is not intended to be comprehensive or to render advice. Websites rendered are subject to change.**

Bulletin Board

Contents

MAR. 03, 2023

HAZARD ALERT

Styrene19

GOSSIP

Propylene glycol prevents airborne transmission of respiratory viruses.....26

Cubed wombat poo puzzle completed by researchers with the help of physics, volcanic science28

Researchers Solve 80-Year-Old Vitamin D Medical Mystery That Claimed Infant Lives31

Antimatter: how the world's most expensive — and explosive — substance is made.....34

New anti-corrosion polymer highlights damage, self-heals and is recyclable39

1000x Faster: World's Fastest Laser Camera Films Combustion in Real Time40

Electrodes build themselves inside the bodies of live fish.....41

Earth's Russian nesting doll structure has a fifth layer we never knew about – the "innermost inner core"43

It's not just exercise that improves your mental health – intensity and type matters too45

Recycled Glass, Turned into Sand, Is Restoring Louisiana's Shrinking Coastline46

CURIOSITIES

Want to travel to Mars? Here's how long the trip could take.....50

How do bats live with so many viruses? New bat stem cells hint at an answer53

How Widespread Are These Toxic Chemicals? They're Everywhere.55

Life Mystery Solved: What Determines the Lifespan of a Tree Leaf?57

E. coli bacteria turned into nanowire factory for artificial nose59

Astronomers Discover Bizarre "Forbidden" Planet That Should Not Exist...61

Engineered wood gets stronger while trapping CO262

Physicists give the first law of thermodynamics a makeover64

NASA has good news for people who like the idea of being alive.....66

Will future computers run on human brain cells?67

Bulletin Board

Contents

MAR. 03, 2023

TECHNICAL NOTES

(Note: Open your Web Browser and click on Heading to link to section) ...70

CHEMICAL EFFECTS70

ENVIRONMENTAL RESEARCH70

PHARMACEUTICAL/TOXICOLOGY70

OCCUPATIONAL.....70

Bulletin Board

Regulatory Update

MAR. 03, 2023

ASIA PACIFIC

Proposal P1059 - Energy labelling on alcoholic beverages

2023-02-01

Proposal P1059 will consider amending the Code to provide energy (kilojoule) labelling information on alcoholic beverages.

FSANZ has extended the timeframe for submissions by 3 weeks and invites written submissions to the following call for submissions paper by 6pm (Canberra time) Monday 20 March 2023.

Call for submissions: 16 January 2023

Read More

Food Standards Australia New Zealand, 01-02-23

<https://www.foodstandards.gov.au/code/proposals/Pages/Proposal-P1059---Energy-labelling-on-alcoholic-beverages.aspx>

Mumbai's air quality worst in February in four years

2023-02-20

Mumbai AQI: Mumbai's air quality index (AQI) was "poor" for eight days between February 1 and 16, according to a recent report. This is a significant increase in poor air quality in comparison to the same period in 2022 and 2021, where the city only saw two days with poor AQI, and none in 2020. Pollutants such as PM 10 and PM 2.5 were the major contributors to this increase. Experts have stated that real estate and infrastructure work, along with transportation, are the main reasons for this rise in air pollution. Heavy traffic and low winter temperatures were also cited as possible causes.

The report's findings are the second such report on deteriorating air quality in Mumbai in recent times. According to a report by IQAir, a Swiss company that tracks global air quality, Mumbai ranked as the second most polluted city in the world between January 29 and February 8. Experts attribute the rise in pollution levels to the dust and smoke generated by vehicles and construction activities.

Bulletin Board

Regulatory Update

MAR. 03, 2023

Read More

India TV News Desk, 20-02-23

<https://www.indiatvnews.com/maharashtra/mumbai-s-air-quality-worst-in-february-in-four-years-2023-02-20-848318>

Proposal P1010 – Review of Formulated Supplementary Sports Foods

2023-02-01

FSANZ invites written submissions on the assessment of Standard 2.9.4 – Formulated Supplementary Sports Foods of the Code. Submissions close 6pm (Canberra time) 9 March 2023.

Read More

Food Standards Australia New Zealand, 01-02-23

<https://www.foodstandards.gov.au/code/proposals/Pages/P1010.aspx>

APVMA Gazette No. 4, 21 February 2023

2023-02-21

Contents

- Agricultural chemical products and approved labels – 1
- Veterinary chemical products and approved labels – 12
- Approved active constituents – 16
- Licensing of veterinary chemical manufacturers – 18
- Variations to Schedule 20 of the Australian New Zealand Food Standards Code – 20
- Agvet chemical voluntary recall: AUSLEPTO VACCINE – 35
- Agvet chemical voluntary recall: Nufarm 2,4-D Amine 625 Herbicide – 36
- Notice of cancellation at the request of the holder – 38

Content last updated

21 February 2023

Content last reviewed

21 February 2023

Bulletin Board

Regulatory Update

MAR. 03, 2023

[Read More](#)

APMVA, 21-02-23

<https://apvma.gov.au/node/109681>

Proposal P1061- Code Maintenance Proposal 2023

2023-02-01

The purpose of this proposal is to make minor amendments to the Code. Submissions close 6pm (Canberra time) 3 March 2023.

[Read More](#)

Food Standards Australia New Zealand, 01-02-23

<https://www.foodstandards.gov.au/code/proposals/Pages/P1061-Code-Maintenance-Proposal-2023.aspx>

Application A1227 Alpha-arabinofuranosidase from GM *Trichoderma reesei* as a processing aid

2023-02-01

FSANZ invites written submissions on the assessment a new source microorganism, being alpha-arabinofuranosidase from a genetically modified strain of *Trichoderma reesei* as a processing aid for use in brewing, fats and oils processing, grain processing and potable alcohol production. Submissions close 6pm (Canberra time) 22 March 2023.

[Read More](#)

Food Standards Australia New Zealand, 01-02-23

<https://www.foodstandards.gov.au/code/applications/Pages/A1227%20-%20Alpha-arabinofuranosidase%20from%20GM%20Trichoderma%20reesei%20as%20a%20processing%20aid.aspx>

Application A1228 Endo-1,4-beta-xylanase from GM *Trichoderma reesei* (gene donor: *Talaromyces leycettanus*) as a processing aid

2023-02-01

FSANZ invites written submissions on the assessment a new source microorganism, being endo-1,4 beta-xylanase from a genetically modified strain of *Trichoderma reesei* as a processing aid for use in brewing, fats

Bulletin Board

Regulatory Update

MAR. 03, 2023

and oils processing, grain processing and potable alcohol production. Submissions close 6pm (Canberra time) 22 March 2023.

[Read More](#)

Food Standards Australia New Zealand, 01-02-23

<https://www.foodstandards.gov.au/code/applications/Pages/A1228---Xylanase-enzyme-from-GM-Trichoderma-reesei.aspx>

Application A1229 Carboxypeptidase from GM *Aspergillus oryzae* as a processing aid

2023-02-01

FSANZ invites written submissions on the assessment of carboxypeptidase, sourced from GM *Aspergillus oryzae*, as a processing aid in the manufacture and/or processing of proteins, yeast and flavourings; the manufacture of bakery products; and brewing. Submissions close 6pm (Canberra time) 22 March 2023.

[Read More](#)

Food Standards Australia New Zealand, 01-02-23

[https://www.foodstandards.gov.au/code/applications/Pages/A1229-Carboxypeptidase-from-GM-Aspergillus-oryzae-as-a-processing-aid-\(enzyme\)-.aspx](https://www.foodstandards.gov.au/code/applications/Pages/A1229-Carboxypeptidase-from-GM-Aspergillus-oryzae-as-a-processing-aid-(enzyme)-.aspx)

AMERICA

Would better regulations and equipment mandates have prevented the Ohio rail disaster?

2023-02-18

In the aftermath of the train derailment and hazardous chemical spill that happened on the evening of February 3 in East Palestine, Ohio, questions linger about the cause of the accident and officials continue to lay blame on one another. While residents worry about the safety of the air and water as they return to their homes, questions about regulations and infrastructure funding linger.

The National Transportation Safety Board (NTSB) and Federal Railroad Association are launching an investigation but it could take months — or even years — for officials to determine what caused the accident. Still, the

Bulletin Board

Regulatory Update

MAR. 03, 2023

NTSB has promised it will deliver a preliminary report of its investigation within two weeks. Surveillance footage seemed to capture video of the train's wheel bearing overheating almost 20 miles away from where the train went off the tracks.

As Vox's Umair Irfan explained: "Rail workers, government officials, and industry analysts have long warned that such disasters are an expected consequence of an industry that has aggressively cut costs, slashed its workforce, and resisted regulation for years."

Since returning to East Palestine on February 8, residents have reported symptoms including nausea, headaches, and rashes. At a recent town hall, community members demanded answers to questions about the long-term health impacts of exposure to the chemicals. Norfolk Southern representatives weren't in attendance for that meeting but CEO Alan Shaw did meet with town officials on Saturday. "We know we will be judged by our actions, and we are taking this accountability and responsibility very seriously," Shaw said in a prepared statement.

This follows another statement from Norfolk Southern on Friday that they are "committed to coordinating the cleanup project and paying for its associated costs."

Despite assurances from EPA Administrator Michael Regan and Governor Mike DeWine, it's unclear if the air and water are safe because air quality monitors lack the sensitivity to detect low-level particles. Even more concerning, Delphine Farmer, a chemist at Colorado State University told Vox's Benji Jones, is that scientists don't really know what level of exposure is safe over the long term.

Read More

Vox, 18-02-23

<https://www.vox.com/2023/2/18/23604604/ohio-rail-disaster-regulations-and-equipment-mandates-chemical-spill>

Water Utilities Brace for Imminent EPA Proposal on PFAS in Water

2023-02-17

Drinking water systems are preparing for the possibility that the EPA will try to codify its 2022 health advisories suggesting no amount of PFAS substances are safe, water attorneys say.

Bulletin Board

Regulatory Update

MAR. 03, 2023

The Environmental Protection Agency is expected to issue its proposed PFAS drinking water standards by March 3, according to the EPA's latest regulatory agenda. That date is exactly two years after the agency published its 2021 decision to regulate per- and polyfluoroalkyl substances, or PFAS, under the Safe Drinking Water Act.

The EPA, which did not respond to a request for comment, said in a news release this week that the draft of the proposed rule is undergoing interagency review, and the proposal will be released in the "coming weeks." The agency said it expects to finalize the PFAS drinking water limits by the end of the year.

"Whatever they come up with will have a huge impact on the next several years for drinking water systems planning their budgeting," and litigation will likely follow, said Tom Lee, a partner at Bryan Cave Leighton Paisner LLP in San Francisco.

The EPA in 2022 issued interim health advisories that said almost no levels of two PFAS substances in drinking water are safe. The question now is whether the agency's proposed limits for PFAS in drinking water will reflect the non-binding advisory.

The advisory set safe PFAS levels "so low that most if not all public water systems can't even detect it," said John Kindschuh, an attorney at Bryan Cave Leighton Paisner in St. Louis who works with Lee on PFAS regulatory issues.

The interim advisory levels of 0.004 parts per trillion (ppt) for perfluorooctanoic acid (PFOA) and 0.02 ppt for perfluorooctanesulfonic acid (PFOS) dramatically tightened EPA's 2016 advisory of 70 ppt for either compound or a combination of both.

The EPA is "telegraphing that that the maximum contaminant levels will be incredibly low values," Lee said.

Read More

Bloomberg Law, 17-02-23

<https://news.bloomberglaw.com/environment-and-energy/water-utilities-brace-for-imminent-epa-proposal-on-pfas-in-water>

Bulletin Board

Regulatory Update

MAR. 03, 2023

The race to waterproof outdoor gear — without toxic chemicals

2023-02-20

Patagonia Inc. has spent nearly a decade rejiggering its supply chain, redesigning products and dumping millions of dollars into a high-stakes trial-and-error process that's nearly complete.

For the Ventura outdoor clothing retailer, this isn't about optimizing for fashion.

Patagonia, like practically every other outdoor apparel company, has long relied on per- or polyfluorinated chemicals — PFAS for short — to make its products water-resistant.

The problem is that these chemicals, also known as fluorochemicals, PFC chemicals or forever chemicals, are toxic. They've been linked to cancer and other health problems and they don't degrade easily: PFAS have been found in drinking water and in the human bloodstream.

Despite years of warnings from scientists and environmental activists, many apparel retailers only recently started sussing out how to ditch PFAS in outdoor apparel and gear. But the stragglers may not be able to straggle much longer: Bans on the chemicals are coming.

Read More

Los Angeles Times, 20-02-23

<https://www.latimes.com/business/story/2023-02-20/the-race-to-waterproof-outdoor-gear-without-toxic-chemicals>

Biden administration restores Obama-era mercury rules for power plants, eyes more regulations in coming months

2023-02-17

The Biden administration on Friday finalized a decision to reestablish Obama-era rules that require coal and oil-fired power plants to reduce toxic pollutants, including mercury and acid gas, that come out of their smokestacks.

Mercury is a neurotoxin with several health impacts, including harmful effects on children's brain development. And while the updated rule significantly benefits public health for communities around these kinds

Bulletin Board

Regulatory Update

MAR. 03, 2023

of power plants, it also has the effect of requiring plants to cut down on planet-warming pollution that comes from burning coal to generate electricity.

President Joe Biden's Environmental Protection Agency announced early last year that it intended to undo a Trump-era rollback of the 2012 mercury pollution rules, one of many Trump-era environmental decisions it has reversed.

"This is a really good day for public health in this country," EPA Deputy Administrator Janet McCabe told CNN. "We're talking about mercury, arsenic, acid gases; these are dangerous pollutants that impact people's health."

The EPA estimates the 2012 rule brought down mercury emissions from power plants by 86% by 2017, while acid gas emissions were reduced by 96%.

McCabe said the EPA is currently working on its own, stronger mercury standard that it expects to propose "not too long from now" and finalize before the end of Biden's first term.

Read More

CNN, 17-02-23

<https://edition.cnn.com/2023/02/17/politics/epa-mercury-power-plant-rules-climate>

Water Utilities Brace for Imminent EPA Proposal on PFAS in Water

2023-02-17

Drinking water systems are preparing for the possibility that the EPA will try to codify its 2022 health advisories suggesting no amount of PFAS substances are safe, water attorneys say.

The Environmental Protection Agency is expected to issue its proposed PFAS drinking water standards by March 3, according to the EPA's latest regulatory agenda. That date is exactly two years after the agency published its 2021 decision to regulate per- and polyfluoroalkyl substances, or PFAS, under the Safe Drinking Water Act.

The EPA, which did not respond to a request for comment, said in a news release this week that the draft of the proposed rule is undergoing

Bulletin Board

Regulatory Update

MAR. 03, 2023

interagency review, and the proposal will be released in the “coming weeks.” The agency said it expects to finalize the PFAS drinking water limits by the end of the year.

“Whatever they come up with will have a huge impact on the next several years for drinking water systems planning their budgeting,” and litigation will likely follow, said Tom Lee, a partner at Bryan Cave Leighton Paisner LLP in San Francisco.

The EPA in 2022 issued interim health advisories that said almost no levels of two PFAS substances in drinking water are safe. The question now is whether the agency’s proposed limits for PFAS in drinking water will reflect the non-binding advisory.

The advisory set safe PFAS levels “so low that most if not all public water systems can’t even detect it,” said John Kindschuh, an attorney at Bryan Cave Leighton Paisner in St. Louis who works with Lee on PFAS regulatory issues.

Read More

Bloomberg, 17-02-23

<https://news.bloomberglaw.com/environment-and-energy/water-utilities-brace-for-imminent-epa-proposal-on-pfas-in-water>

EPA Updates TSCA Inventory, Plans Next Update in Summer 2023

2023-02-17

The U.S. Environmental Protection Agency (EPA) announced on February 16, 2023, that the latest Toxic Substances Control Act (TSCA) Chemical Substance Inventory is now available on its website. The TSCA Inventory is a list of all existing chemical substances manufactured, processed, or imported in the United States. According to EPA, this update to the public TSCA Inventory is part of its biannual posting of non-confidential Inventory data. EPA plans the next regular update of the TSCA Inventory for summer 2023.

EPA states that the TSCA Inventory contains 86,685 chemicals, of which 42,170 are active in U.S. commerce. Other updates to the Inventory include new commercial activity data, unique identifier data, and regulatory flags (e.g., significant new use rules and test orders). EPA notes that additionally, several hundred substances are now listed with their specific chemical identities after having been moved from the confidential portion of the

Bulletin Board

Regulatory Update

MAR. 03, 2023

Inventory to the public portion as part of EPA’s TSCA confidential business information (CBI) review efforts.

Lastly, EPA reminds TSCA submitters to check regularly for any correspondence relating to their submissions in EPA’s Central Data Exchange (CDX). EPA states that it sends “critical and time-sensitive information regarding confidentiality claims through CDX, and failing to open this correspondence can delay the Agency’s processing of those claims.”

Read More

TSCA Blog, 17-02-23

<https://www.tscablog.com/entry/epa-updates-tsca-inventory-plans-next-update-in-summer-2023>

EUROPE

HSE publishes restriction opinion on tattoo and permanent make-up inks

2023-02-14

A detailed analysis on substances that could cause health risks to adults in Britain who get tattoos or permanent make up has been published.

Following a six-month public consultation last year on a restriction proposal for certain hazardous substances in tattoo and permanent make up inks, the Health and Safety Executive (HSE), in its role as the agency for UK REACH, has published its risk assessment opinion.

This is the first analysis of its kind to have been published under UK REACH, the standalone chemicals regime established after the UK left the EU.

Today’s published opinion on the restriction proposal was developed after considering responses from last year’s consultation. Additionally, in line with the legal requirements under the UK Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Regulation, HSE also opened a 60-day public consultation on the draft socio-economic opinion for the same dossier. Any comments that will help HSE with this assessment should be submitted here.

Bulletin Board

Regulatory Update

MAR. 03, 2023

Dr Richard Daniels, HSE's Director of Chemicals Regulation Division, said: "Tattoo and permanent makeup inks could contain substances that are harmful to us. Some of these substances, for example, could trigger allergic reactions in the skin.

"We have listened carefully to the tattooing community. For example our proposals refer to two pigments which would, after careful assessment, be allowed to be used.

"While tattoo artists have measures to keep their work hygienic, there are currently no regulatory controls in Great Britain for substances in inks used for tattooing and permanent makeup."

Read More

HSE, 14-02-23

<https://press.hse.gov.uk/2023/02/14/hse-publishes-restriction-opinion-on-tattoo-and-permanent-make-up-inks>

Are the EU's proposed new packaging regulations fit for purpose?

2023-02-24

Could the proposed wide-ranging revisions to the EU's Packaging and Packaging Waste Directive cause more harm than good in their current iteration? Isabell Schmidt and Martin Engelmann of the IK German Plastic Packaging Association, which represents around 300 mainly SMEs in the areas of plastic packaging and plastic film, give their perspective on how the revisions could be improved – and the parts they think might benefit the industry.

The European Commission's proposal for an EU Packaging Regulation, published on 30 November 2022, offers an opportunity for the sustainable transformation of the packaging industry. Plastic packaging manufacturers in Germany have invested in the recyclability of their products and are ready with innovative solutions that combine high material efficiency with high-grade recyclability and the use of recycled materials. In order not to jeopardise sustainable transformation, the regulation should be adopted before the European Parliament elections in 2024.

However, the draft also contains considerable economic and ecological risks for misguided decisions, which should be corrected in the legislative process. This concerns above all mandatory recycled content quotas for contact-sensitive packaging (e.g. for food and dangerous goods) and the

Bulletin Board

Regulatory Update

MAR. 03, 2023

discrimination of packaging made of plastic. Also, all delegated acts that concretise the sustainability and labelling requirements for packaging should be timed and industry should be given the opportunity to have its say.

In detail, we welcome the following points in the EU Commission's proposal:

Replacing the previous directive with a regulation - directly effective for companies and member states - facilitates the enforcement of harmonised packaging rules in the EU internal market and protects the free exchange of mostly packaged goods from the growing patchwork of national packaging bans, labelling and design requirements. Harmonised packaging rules are also necessary because only they enable the necessary economies of scale for the economic transformation towards an EU-wide circular economy.

Read More

Packaging Europe, 24-02-23

<https://packagingeurope.com/comment/are-the-eus-proposed-new-packaging-regulations-fit-for-purpose/9426.article>

Bulletin Board

REACH Update

MAR. 03, 2023

'Game over' for EU's REACH chemical safety review, campaigners say

2023-02-19

With the EU elections looming in spring 2024, campaigners worry that European Commission President Ursula von der Leyen will seek to please her political base in Germany with a softball approach to chemicals regulation.

After more than a year of delay, the EU executive is expected to table its long-awaited revision of the REACH regulation on chemicals during the last quarter of 2023.

The REACH regulation was adopted in 2006 to protect human health and the environment from toxic chemicals, and a revision was promised as part of the Commission's chemicals strategy for sustainability, which aims for "a toxic-free environment".

But campaigners fear that the end of von der Leyen's mandate and the European Parliament elections next year will result in further delays and watering down of the proposal.

"This delay is far more significant than 'just one year,'" said Mariana Goulart, policy officer for chemicals at the European Environmental Bureau (EEB), a green umbrella group.

"With European Parliament elections to take place in May 2024, the delay is effectively 'game over' for the REACH reform during this legislature and under this Commission," she told EURACTIV.

Campaigners' concerns are chiefly related to von der Leyen's German origins and the country's love affair with the chemical industry, which accounts for 10% of its economy.

The German chemical sector took a serious hit last year due to the war in Ukraine, which sent gas and electricity prices through the roof. The final straw came in October, when BASF announced it would "permanently" scale back its operations in Europe, citing rising energy costs and concerns over regulation.

This raised the alarm at the highest level of the German government, and campaigners fear von der Leyen will avoid rocking the boat further ahead of an election year.

Bulletin Board

REACH Update

MAR. 03, 2023

"Von der Leyen being German, there is fear that her national political ties may influence her end-of-mandate decisions, especially considering that her own political future may depend on concluding her EU mandate on good terms with her fellow German politicians," Goulart said.

Read More

Euractiv, 19-02-23

<https://www.euractiv.com/section/chemicals/news/game-over-for-eus-reach-chemical-safety-review-campaigners-say/>

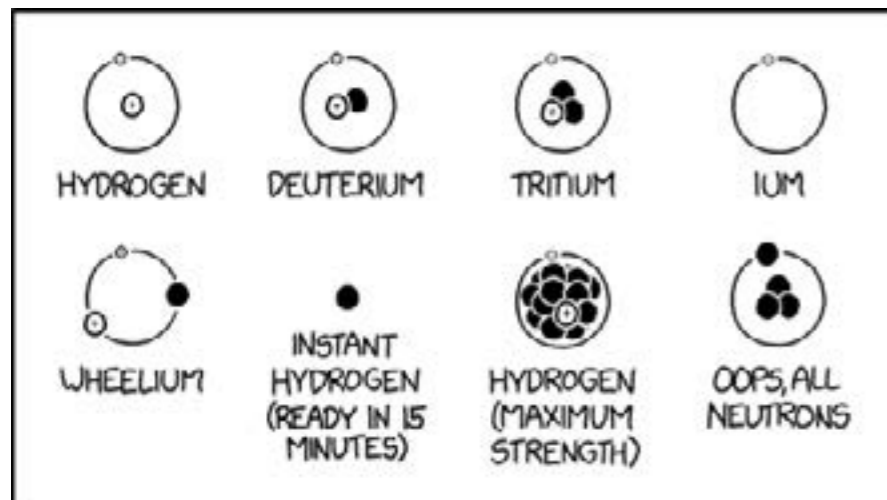
Bulletin Board

Janet's Corner

MAR. 03, 2023

Hydrogen Isotopes

2023-03-03



<https://xkcd.com/2719/>

Bulletin Board

Hazard Alert

MAR. 03, 2023

Styrene

2023-03-03

Styrene, also known as ethenylbenzene, vinylbenzene, and phenylethene, is an organic compound with the molecular formula C_8H_8 . [1]

Pure styrene is a colourless to yellowish oily liquid that evaporates easily and has a sweet smell. It is often mixed with other substances that give it a sharp smell. It is flammable. [2]

USES [2]

When it is linked together in long chains, or polymerised, styrene is used predominantly in the production of polystyrene plastics and resins, such as in insulation or in the fabrication of fibreglass boats; most styrene products contain a residue of unlinked styrene. Styrene is also used to make rubber, and as an intermediate in the synthesis of materials used for ion exchange resins and to produce copolymers such as styrene-acrylonitrile, acrylonitrile-butadiene-styrene, and styrene-butadiene rubber.

SOURCES & ROUTES OF EXPOSURE

Sources of Emission [2]

- Industry sources: Styrene will be emitted to air from industrial process that use or manufacture the material or where it is formed as a by-product.
- Diffuse sources: Styrene is present in combustion products such as cigarette smoke.
- Natural sources: Low levels of styrene occur naturally in a variety of foods, such as fruits, vegetables, nuts, beverages, and meats.
- Transport sources: Styrene is present in car exhaust.
- Consumer products: Products produced from styrene include packaging, electrical and thermal insulation, fibreglass, pipes, car parts, drinking cups and other food-use items, and carpet backing.

Routes of Exposure [3]

The routes of exposure to styrene are through:

- inhalation,
- skin absorption,

Styrene, also known as ethenylbenzene, vinylbenzene, and phenylethene, is an organic compound with the molecular formula C_8H_8 . [1]

Bulletin Board

Hazard Alert

MAR. 03, 2023

- ingestion,
- skin and/or eye contact

IN THE ENVIRONMENT [4]

- Styrene can be found in air, water, and soil after release from the manufacture, use, and disposal of styrene-based products.
- It is quickly broken down in the air, usually within 1 to 2 days.
- Styrene evaporates from shallow soils and surface water.
- Styrene that remains in soil or water may be broken down by bacteria or other microorganisms.
- Styrene is not expected to build up in animals.

HEALTH EFFECT [5]

Acute Effects

- Acute exposure to styrene in humans results in respiratory effects, such as mucous membrane irritation, eye irritation, and gastrointestinal effects.
- Tests involving acute exposure of rats and mice have shown styrene to have low to moderate toxicity by inhalation and oral exposure.

Chronic Effects

- Chronic exposure to styrene in humans results in effects on the central nervous system (CNS), with symptoms such as headache, fatigue, weakness, depression, CNS dysfunction (reaction time, memory, visuomotor speed and accuracy, intellectual function), and hearing loss, peripheral neuropathy, minor effects on some kidney enzyme functions and on the blood.
- Animal studies have reported effects on the CNS, liver, kidney, and eye and nasal irritation from inhalation exposure to styrene.
- Liver, blood, kidney, and stomach effects have been observed in animals following chronic oral exposure.
- The Reference Concentration (RfC) for styrene is 1 milligram per cubic metre (mg/m³) based on CNS effects in occupationally exposed workers.
- The Reference Dose (RfD) for styrene is 0.2 milligrams per kilogram body weight per day (mg/kg/d) based on red blood cell and liver effects in dogs.

Bulletin Board

Hazard Alert

MAR. 03, 2023

Reproductive/Developmental Effects

- Human studies have not reported an increase in developmental effects in women who worked in the plastics industry, while an increased frequency of spontaneous abortions and a decreased frequency of births were reported in a study on the reproductive effects of styrene in humans. However, these studies are not conclusive, due to the lack of exposure data and confounding factors.
- Animal studies have not reported developmental or reproductive effects from inhalation exposure to styrene.
- Lung tumours have been observed in the offspring of orally exposed mice.

Cancer Risk

- Several epidemiologic studies suggest that there may be an association between styrene exposure and an increased risk of leukaemia and lymphoma. However, the evidence is inconclusive due to multiple chemical exposures and inadequate information on the levels and duration of exposure.
- Animal cancer studies have produced variable results and provide limited evidence for carcinogenicity.
- IARC has classified styrene as a Group 2B, possibly carcinogenic to humans.
- Styrene oxide is a reactive metabolite of styrene and shows positive carcinogenic results in oral exposure bioassays. Styrene oxide has been detected in workers exposed to styrene. IARC has classified this metabolite as a Group 2A, probable human carcinogen.
- EPA does not have a carcinogen classification for styrene; the chemical currently is undergoing an EPA Integrated Risk Information System (IRIS) review to establish such a classification.

SAFETY [6]

First Aid Measures

- Eye Contact: Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Do not use an eye ointment. Seek medical attention.
- Skin Contact: After contact with skin, wash immediately with plenty of water. Gently and thoroughly wash the contaminated skin with

Bulletin Board

Hazard Alert

MAR. 03, 2023

running water and non-abrasive soap. Be particularly careful to clean folds, crevices, creases and groin. Cover the irritated skin with an emollient. If irritation persists, seek medical attention. Wash contaminated clothing before reusing.

- Serious Skin Contact: Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.
- Inhalation: Allow the victim to rest in a well-ventilated area. Seek immediate medical attention.
- Ingestion: Do not induce vomiting. Examine the lips and mouth to ascertain whether the tissues are damaged, a possible indication that the toxic material was ingested; the absence of such signs, however, is not conclusive. Loosen tight clothing such as a collar, tie, belt or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention.

Fires & Explosion Information

- Styrene is flammable.
- Auto-ignition temperature is 490°C (914°F)
- Flash Points: closed cup is 31.1°C (88°F) and open cup is 36.7°C (98.1°F).
- Styrene is flammable in the presence of open flames and sparks and slightly flammable to flammable in the presence of heat.
- Dry chemical powder should be used to extinguish small fires.
- Alcohol foam, water spray or fog should be used to extinguish large fires.
- Cool containing vessels with water jet in order to prevent pressure build-up, autoignition or explosion.

Exposure Controls & Personal Protection

Engineering Controls

The following engineering controls should be provided when handling styrene:

- Exhaust ventilation or other engineering controls to keep the airborne concentrations of vapours below their respective threshold limit value.
- Ensure that eyewash stations and safety showers are proximal to the work-station location.

Bulletin Board

Hazard Alert

MAR. 03, 2023

Personal Protective Equipment

The following personal protective equipment should be used when handling styrene:

- Splash goggles;
- Lab coat;
- Vapour respirator (be sure to use an approved/certified respirator or equivalent);
- Gloves.

Personal Protective Equipment in Case of a Large Spill:

- Splash goggles;
- Full suit;
- Vapour respirator;
- Boots;
- Gloves;
- A self contained breathing apparatus should be used to avoid inhalation of the product.
- Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

REGULATION

UNITED STATES [7]

Exposure Limit	Limit Values	HE Codes	Health Factors and Target Organs
OSHA Permissible Exposure Limit (PEL) – General Industry See 29 CFR 1910.1000 Table Z-2 (See also ANSI Z37.15-1969)	100 ppm TWA 200 ppm Ceiling Exception to ceiling value: 600 ppm (peak), for a single time period up to 5 minutes for any 3 hours	HE7	Central nervous system depression
		HE11	Irritation of the lungs
		HE15	Eye, nose, and skin irritation

Bulletin Board

Hazard Alert

MAR. 03, 2023

Exposure Limit	Limit Values	HE Codes	Health Factors and Target Organs
OSHA PEL – Construction Industry See 29 CFR 1926.55 Appendix A	100 ppm (420 mg/m ³) Ceiling	HE7	Central nervous system depression
		HE11	Irritation of the lungs
		HE15	Eye, nose, and skin irritation
OSHA PEL – Shipyard Employment See 29 CFR 1915.1000 Table Z-Shipyards	100 ppm (420 mg/m ³) TWA	HE7	Central nervous system depression
		HE11	Irritation of the lungs
		HE15	Eye, nose, and skin irritation
National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL)	50 ppm (215 mg/m ³) TWA 100 ppm (425 mg/m ³) STEL	HE2	Mutagenic effects, including cytogenic changes
		HE7	Central nervous system depression
		HE8	Narcosis
		HE15	Eye, nose, throat, and skin irritation
American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) (2001) (Listed under Styrene, Monomer)	20 ppm TWA 40 ppm STEL A4; BEI	HE2	Chromosomal abnormalities in peripheral lymphocytes
		HE7	Central nervous system depression; peripheral nervous system impairment; optic and otoneurologic impairment
		HE15	Irritation of eyes, mucous membranes, upper respiratory system, and skin

Bulletin Board

Hazard Alert

MAR. 03, 2023

Exposure Limit	Limit Values	HE Codes	Health Factors and Target Organs
CAL/OSHA PELs	50 ppm (215 mg/m ³) TWA 500 ppm Ceiling 100 ppm (425 mg/m ³) STEL Skin		

Australia [2]

Safe Work Australia: Safe Work Australia has established an eight hour time weighted average (TWA) exposure limit for styrene of 50 ppm (213 mg/m³) and a short term exposure limit (STEL) of 100 ppm (426 mg/m³)

Australian Drinking Water Guidelines (NHMRC and ARMCANZ, 1996):

- Health: Maximum of 0.03 mg/L (i.e. 0.00003 g/L)
- Aesthetic: Maximum of 0.004 mg/L (i.e. 0.000004 g/L)

REFERENCES

1. <http://en.wikipedia.org/wiki/Styrene>
2. <http://www.npi.gov.au/resource/styrene-ethenylbenzene>
3. <http://www.cdc.gov/niosh/npg/npgd0571.html>
4. <http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=420&tid=74>
5. <http://www.epa.gov/ttn/atw/hlthef/styrene.html>
6. <http://www.sciencelab.com/msds.php?msdsId=9925112>
7. https://www.osha.gov/dts/chemicalsampling/data/CH_268200.html

Bulletin Board

Gossip

MAR. 03, 2023

Propylene glycol prevents airborne transmission of respiratory viruses

2023-02-20

In a recent study posted to the bioRxiv* preprint server, researchers in the United Kingdom assess the ability of propylene glycol (PG) to inactivate infection caused by respiratory viruses and prevent airborne transmission.

Approaches to reduce viral transmission

The use of masks, physical distancing, lockdowns, and travel restrictions are some of the public health and societal strategies used to control respiratory virus transmission. Other ways to eliminate viruses from the environment include increasing ventilation along with frequent disinfection; however, both of these approaches are associated with certain limitations, such as the possible effects of extended and extensive disinfectant use on health and the environment.

Mice exposed to airborne influenza might be protected by PG vapor. PG vapor has also been shown to reduce vaccination- and influenza-mediated mortality in chick embryos. Nevertheless, the effect of PG on the infectivity of viral particles has yet to be directly evaluated and, as a result, remains poorly understood.

About the study

In the present study, researchers examine the virucidal effect of PG and whether it can inhibit respiratory virus transmission through droplet, fomite, and aerosol pathways.

To determine whether PG has virucidal activity, the team studied the influenza A virus (IAV), which causes seasonal outbreaks among humans and birds. Infectivity was assessed by titrating IAV treated with various doses of PG. To test the translational ability of PG-mediated virucidal action against IAV, in vivo inhalation of IAV followed by treatment with PG was also assessed.

To investigate the broader usage of PG activity in response to pathogenic viruses, a pseudovirus system was engineered to express viral envelope glycoproteins found in a variety of human pathogens such as several strains of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), 229E and NL63 seasonal coronaviruses, Ebola, and the Middle Eastern respiratory syndrome coronavirus (MERS).

Infection by airborne SARS-CoV-2 and IAV was stimulated through the use of a transmission tunnel system. Herein, permissive cell monolayers at

Bulletin Board

Gossip

MAR. 03, 2023

various distances within the transmission tube were exposed to airborne virus droplets in the presence of vaporized PG concentrations ranging between 0 mg/L to 11 mg/L air. After exposure, the area of the viral plaque was calculated.

Study findings

PG significantly inhibited IAV infection of cultured cells, whose virucidal activity was dependent on PG concentration and viral incubation period. IAV inactivation mediated by PG was temperature-dependent, as virucidal activity at skin and nasal temperature of 32°C and body temperature of 37°C relative to 20°C.

At physiological temperatures, the team noted that 60% PG decreased IAV infectivity by almost 10,000-fold within five minutes, with its antiviral efficacy reaching undetectable amounts after 30 minutes. This revealed that PG has significant virucidal properties. Furthermore, 20% PG produced the lowest statistically significant decrease in IAV infectivity detected at nasal temperature.

Mice infected IAV and subsequently treated with IAV survived longer and exhibited less clinical symptoms than untreated mice. Three out of five mice infected with IAV only displayed very poor clinical scores.

PG inactivated the SARS-CoV-2 IC19 strain with greater efficacy than when used to treat IAV infection. After one minute of 50% PG treatment at room temperature, the infectivity of SARS-CoV-2 declined by over 1,000-fold, thus demonstrating persistent virucidal activity.

PG also effectively decreased the infectiousness of the enveloped double-stranded deoxyribonucleic acid (DNA) g-herpesvirus Epstein Barr (EBV). Like SARS-CoV-2 and IAV, PG exhibited a strong virucidal response against EBV, as demonstrated by a more than 1,000-fold decrease in viral titers following incubation with 50% PG.

A bioluminescence-based assay examining infectivity showed that PG dramatically inhibited the ability of every pseudovirus to infect cells and limited their entry into vulnerable cells in a dose-dependent way. While PG consistently reduced infectivity, the amount required to elicit this effect differed across the various glycoproteins released by pseudoviruses. This reflects the varying specific potency of PG against SARS-CoV-2, EBV, and IAV viral particles.

PG vapor attenuated the infectiousness of airborne SARS-CoV-2 and IAV in a dose-dependent manner and eliminated infection within a distance

Bulletin Board

Gossip

MAR. 03, 2023

of less than 1 meter. Similar to PG in nebulized droplets, the vapor form of this treatment exhibited more effective virucidal activity as compared to PG in solution.

Efficient and quick PG-mediated inactivation of airborne SARS-CoV-2 and IAV was observed at viral concentrations exceeding the predicted amounts ejected by speaking or coughing. Moreover, 1.5 mg PG/L air was found to effectively eliminate infectivity when less IAV amounts were nebulized into the tunnel to simulate an amount equivalent to numerous human coughs.

Conclusions

PG vapor was found to be an excellent candidate for restricting different viral infections through multiple routes, such as aerosol, fomite, and droplet transmission. Taken together, the study findings demonstrate PG to be an economical and effective virucide that was safe to consume and inhale, particularly when compared to other fumigation systems and disinfectants. The prospective implementation of PG as an infection prevention tool and virucidal deserves additional exploration.

News Medical, 20 February 2023

<https://news-medical.net>

Cubed wombat poo puzzle completed by researchers with the help of physics, volcanic science

2023-02-21

Puddle, log, pellet or cube? Mammal life is diverse, and so are the poos mammals produce.

But, to quote the father of evolutionary biology, Charles Darwin: What is behind “these endless forms most beautiful and most wonderful?”

A team of scientists from around the world — including associate professor Scott Carver from the University of Tasmania — have turned their minds to this question and found some fascinating faecal facts.

It is not the first time the disease ecologist’s poo research has made a splash.

He and his colleagues discovered that wombats’ famously square-shaped poo was created within the intestine and not at “point of exit”.

This nabbed them an Ig Nobel Prize in 2018 — a prestigious award for science that makes you laugh and then makes you think.

Bulletin Board

Gossip

MAR. 03, 2023

However, questions about the peculiar poo still remained.

“We understood how they produced the corners that give them the square shape in cross-section,” Dr Scott Carver told ABC Hobart’s Helen Shield.

“But not why they fragmented at such regular intervals along the length and came out as perfectly consistent little poos that are about the same length.”

Turning to volcano science and physics to uncover the answer, the researchers have not only discovered why wombats have “perfectly consistent little poos”, but also what determines the shape of mammal poo in general.

Why look to volcanoes?

It was the cooling process of lava beds that inspired Dr Carver and his collaborators.

After an eruption, lava beds cool and can solidify into specific and regular shapes.

One of the most famous places to see the results of this process is The Giant’s Causeway in Northern Ireland.

“They have these hexagonal structures that are really consistent,” he said.

The structures were formed because the lava they were made from cooled more slowly on the surface than internally, creating forces that resulted in regular cracking.

This got Dr Carver and his team wondering: “Does the same sort of principle apply to faeces and the sorts of different lengths and shapes that you get?”

Except, unlike lava beds, the cracking of mammal poo occurs before expulsion, in the large intestine.

What do lava beds and intestines have in common?

As food travels through a digestive system, it gets broken down and digested, leaving a sloppy “slurry” of waste, Dr Carver says.

During the digestion process, the slurry enters the distal colon, where the body reclaims some of the moisture from the waste.

Bulletin Board

Gossip

MAR. 03, 2023

“For a while, the moisture of the faeces is so much that it doesn’t really matter ... they are still the slurry ... but eventually they start to get drier,” Dr Carver said.

The researchers had an inkling that this drying process created cracks through “water flux” in a similar way to how “heat flux” created the even hexagons of The Giants Causeway.

Testing their theory

In the lab, the team recreated the drying of waste in the intestine.

Corn starch was used to simulate poo and the stand-in for intestines were plastic troughs.

Heat lamps were used to dry the corn starch slurry at different rates and then the researchers analysed crack formation.

The greater the drying, the more closely spaced the cracks.

The water flux creates a “shearing process” that influences how regularly the breaks in the faeces occur — just as heat flux sheared the cooling lava of The Giants Causeway.

So, a wombat’s distinctive cubic poo is a result of the drying forces of its intestine being just right for the creation of poo that’s about as long as it is high.

Mystery solved.

What about other poo shapes?

The researchers also compared the surprisingly ample data available on poo shape and water content — so what is the scoop?

They found that when the water content of faeces dropped below 70 per cent, cracks formed and animals produced pellet-shaped poo.

“Whereas humans have about 75 per cent [water content in our stools]. So it is much wetter and we produce tubes most of the time,” Dr Carver said.

Cow pats and their sloppy ilk occur when poo reaches 85 to 90 per cent water: “Then it is just a puddle,” he said.

While the heady world of animal poo formation might seem distant from the doctor’s office, Dr Carver believes this research may one day help medical scientists.

Bulletin Board

Gossip

MAR. 03, 2023

“Colorectal cancer, stress and various other things can influence the kind of faeces that people produce,” he said.

While he says there will not be any direct medical breakthroughs from his work, it will add to “cumulative knowledge that contributes to helping understand human medical conditions”.

ABC News, 21 February 2023

<https://abc.net.au>

Researchers Solve 80-Year-Old Vitamin D Medical Mystery That Claimed Infant Lives

2023-02-21

Scientists at the University of East Anglia have solved a long-standing medical mystery that causes kidney damage in children and can be fatal in babies. Those with the condition are unable to metabolize vitamin D properly. This leads to an accumulation of calcium in the blood and causes kidney damage and the formation of kidney stones.

This resulted in a surge of infant fatalities during the 1930s and 1940s, as a result of fortifying foods such as milk, bread, cereal, and margarine with Vitamin D in an effort to eliminate rickets in children.

Recent research had shown that the condition, now known as infantile hypercalcemia type 1, is caused by a gene mutation. But curiously, around 10 percent of patients experiencing symptoms do not have the genetic mutation.

“This really puzzled us,” said lead researcher Dr. Darrell Green, from UEA’s Norwich Medical School. “So we wanted to find out exactly why this 10 percent appeared to have the condition, but without the gene mutation that was found to cause it.”

The puzzle began in the early 1900s, when more than 80 percent of children in industrialized Europe and North America were affected by rickets, which causes bone pain, poor growth, and soft, weak, deformed bones.

The discovery that sunlight prevented rickets led to the fortification of foods with vitamin D, which all but eradicated the disease by the 1930s. But outbreaks of vitamin D intoxication in infants led to fortification bans in many European countries by the 1950s.

This resulted in a surge of infant fatalities during the 1930s and 1940s, as a result of fortifying foods such as milk, bread, cereal, and margarine with Vitamin D in an effort to eliminate rickets in children.

Bulletin Board

Gossip

MAR. 03, 2023

Dr. Green said: "Foods such as dairy products had been fortified with vitamin D, but it led to a number of baby deaths and was eventually banned in many countries except for in breakfast cereals and margarine. In 2011, researchers found that some people are born with a mutation in the CYP24A1 gene, which means they cannot metabolize vitamin D properly. This causes a build-up of calcium in the blood, leading to kidney stones and kidney damage, which can be fatal in babies. It was the reason why vitamin D-fortified food in the 1930s caused intoxication in some people."

He continues, "Today, some people do not realize they have a CYP24A1 mutation until they are adults, after years of recurrent kidney stones and other problems. In most cases, these patients are screened and find out that they have the CYP24A1 mutation and the disorder now known as infantile hypercalcemia type 1, or HCINF1. However, in around 10 percent of suspected HCINF1 patients, they do not display an obvious mutation in CYP24A1 and continue to have lifelong problems without a proper diagnosis."

The UEA team collaborated with colleagues at the Norfolk and Norwich University Hospital, where they worked with 47 patients.

They used a combination of next-generation genetic sequencing and computational modeling to study blood samples from those '10 percent' of puzzling patients.

Dr. Green said: "A Ph.D. student in my laboratory, Nicole Ball, carried out a more extensive genetic analysis of six patient blood samples and we found that the physical shape of the CYP24A1 gene in these apparent HCINF1 patients is abnormal."

"This tells us that gene shape is important in gene regulation – and that this is the reason why some people lived with HCINF1 but without a definitive diagnosis," he added.

"On a wider scale relevant to genetics and health, we know that genes must have the correct sequence to produce the correct protein, but in an added layer of complexity, we now know that genes also have to have a correct physical shape," added Dr. Green.

Prof Bill Fraser, from both Norwich Medical School and the Norfolk and Norwich University Hospital, co-led the study and treats HCINF1 patients in metabolic bone clinics.

He said: "Genetic causes of vitamin D toxicity can be left undiagnosed for long periods, well into adulthood, sometimes coming to light during

Bulletin Board

Gossip

MAR. 03, 2023

pregnancy when fortification of mothers with vitamin D happens. We also see patients with undiagnosed causes of recurrent renal stones who have had this condition for many years. Treatment includes avoidance of vitamin D supplementation in subjects with the particular genetic abnormalities we have identified."

"A beneficial side effect to some anti-fungal medications includes alteration of vitamin D metabolism lowering active vitamin D, which decreases calcium levels and can give patients a more normal quality of life, which we have started to prescribe in some patients," he added.

The researchers now plan to investigate the role of gene shapes in other disorders such as cancer.

Case Study – Shelley O'Connor

Shelley O'Connor, 34, from Norwich, was diagnosed with infantile hypercalcemia type 1 eleven years ago when she fell pregnant with her first child at the age of 23.

She had started to take pregnancy supplements, which included vitamin D. But she began to experience a pain so severe that midwives thought she was going into an early labor at just 23 weeks.

"It was very frightening," she said. "I was in a lot of pain, and the midwives thought I was going into labor. I was really scared for the baby, but when I had an MRI, they found out that it was actually a kidney stone caused by taking vitamin D as a pregnancy supplement."

Thankfully, her son was born safe and well at full term, and Shelley has since gone on to have another two children.

"I was diagnosed with HCINF1 and it did explain a lot because I had experienced things like abdominal pain and UTIs in childhood," she said.

But the condition has taken its toll. Shelley now regularly passes kidney stones and needs to take pain medication. She also has to have an operation every six months to clear the calcium build-ups that lead to kidney stones.

"I was really pleased to be invited to take part in the research, and I hope the findings go on to help others like me," she said.

Sci Tech Daily, 21 February 2023

<https://scitechdaily.com>

Bulletin Board

Gossip

MAR. 03, 2023

Antimatter: how the world's most expensive — and explosive — substance is made

2023-02-19

It's the most expensive substance on Earth, costing quadrillions of dollars for a single gram.

It's also likely the most explosive substance on the planet.

Michael Doser — who works in the only factory making it — describes this reaction as “probably the most violent process you can think of because the full mass of the object disappears and transforms into energy”.

And based on what we know about this terrifying-sounding substance, the Universe probably shouldn't exist at all.

So what is it?

Antimatter.

It doesn't sound like it should be real, but “it does exist”, says Professor Doser, a physicist who studies the properties of antimatter at CERN, the European Council for Nuclear Research.

This international scientific institution in Switzerland is home to the Large Hadron Collider, and it regularly exposes the hidden particles that make up our universe.

Lesser known is its role in studying the anti-particles of the Universe.

Professor Doser leads a team studying this strange, expensive, explosive stuff in the wonderfully named Antimatter Factory.

Here they create and capture this bizarre anti-stuff.

What is antimatter?

You can think of it as matter's evil twin.

Professor Doser actually thinks matter might be the evil half of this equation, with antimatter being the “good guy”.

But the point is: antimatter is the opposite of matter.

It's exactly the same as matter, except all the electrical charges of its component parts are reversed.

This is why it's so explosive.

Bulletin Board

Gossip

MAR. 03, 2023

When a bit of matter comes into contact with its evil antimatter twin, they cancel each other out, releasing all the energy stored inside them.

“[When] a proton and antiproton annihilate each other, their mass completely disappears,” Professor Doser says.

“So this is by far the most energetic process that you can think of.”

By converting all their mass into energy, you're getting more bang for your buck with an antimatter explosion.

“In the case of a chemical reaction, you're transforming only about a millionth of the mass of the object of the molecule into energy,” Professor Doser says.

The violence of an antimatter reaction was clearly demonstrated when a tiny pinch of the stuff exploded over Vatican City ... in the fictional Dan Brown epic, Angels and Demons.

Thankfully, outside the realms of science fiction, we won't see antimatter destroying cities anytime soon.

“Even in that hypothesis you'd still need a gram of antimatter, which would take 10 billion years to accumulate,” Professor Doser says.

And for my Trekkie friends out there, that also means fusion-powered warp drives like those on Star Trek ships are unlikely to be a thing any time soon.

So how is antimatter made?

To create antimatter you just need to create matter.

Simple? Nope.

Expensive? You bet.

The recipe they use at CERN's Antimatter Factory to achieve this feat is:

1. Take a proton (a charged subatomic particle)
2. Speed it up enormously
3. Crash it into an iridium block.

One in every million collisions creates a proton-antiproton pair.

The basic principle is that so much energy is concentrated at a single point that it creates mass — the mass of matter.

Is there an opposite twin version of you out there in the Universe made out of this stuff?

Bulletin Board

Gossip

MAR. 03, 2023

And yes, bizarrely, energy can become the mass of matter — and vice versa.

This equivalency is most famously described in Einstein's equation:

$$e \text{ (energy)} = m \text{ (the mass of matter)} \times c \text{ (the speed of light)} \text{ squared}$$

But whenever this happens — when loads of energy gets concentrated and turned into the mass of matter — antimatter is born too.

"Antimatter appears every single time matter appears," Professor Doser says.

The cost of creating antimatter like this makes it the world's most expensive substance.

Professor Doser once estimated how much it would cost to make antimatter in large amounts.

"One 100th of a nanogram [of antimatter] costs as much as one kilogram of gold," he says.

After a bit of number crunching that means a gram of antiproton antimatter would cost an absurd 5 quadrillion euros. That's 5 thousand trillion euros.

There's not really any point translating that to Australian dollars because it's absurd either way.

Other sources of antimatter

And yet, a piece of fruit makes antimatter too. And so do we!

"Bananas are a perfect unit for antimatter production. It's one antiparticle per hour, approximately," Professor Doser says.

As radioisotopes in bananas decay, they release pairs of electrons and anti-electrons.

The same process happens in the human body too, so we're all creating anti-electrons.

But to understand the properties of this mysterious anti-stuff, apparently anti-electrons won't cut it.

Professor Doser and his colleagues need anti-protons.

"You need 2,000 times more energy to make [anti-protons]," he says.

Bulletin Board

Gossip

MAR. 03, 2023

"So we actually need infrastructure like at CERN, accelerators that will produce enough energy locally in a very small spot to produce pairs of an antiproton and a proton."

But ... why would we bother?

Ah yes, the multi-million dollar question.

There are a few answers.

The first is that the technology developed in CERN's Antimatter Factory has been applied in medical imaging tools called PET scanners.

The second is that CERN is interested in fundamental research — understanding things without knowing how this knowledge could be applied.

And the final is that it might help us solve a fairly enormous cosmic conundrum: why the material universe exists.

The Universe probably shouldn't exist

At the moment of the Big Bang, all the energy of the Universe was concentrated and exploded.

"We actually expect that the whole Universe — since there was lots of energy around at the moment of the Big Bang — should consist of equal amounts of matter and antimatter," Professor Doser says.

"The big surprise is that it doesn't."

There is no antimatter left in the Universe from the Big Bang that we're aware of, he says.

Which is fortunate.

If the Big Bang led to equal parts matter and antimatter forming, these probably would have then bumped into each other, obliterated one another, and then presumably exploded again.

"We want to study it to see why it's not here anymore and why the Universe isn't just empty."

So, what's their working theory as to why our evil antimatter twins didn't just cancel everything out, long ago?

Bulletin Board

Gossip

MAR. 03, 2023

“The best explanation that we have found up to now is to say that there’s a slight difference in the properties of particles and antiparticles,” Professor Doser says.

This means that although equal amounts of matter and antimatter should have formed, they weren’t quite equal, he adds.

“One particle is left over out of a billion, and this one particle out of a billion is everything we see in the Universe. All the galaxies, the clusters of galaxies, the stars, the planets, us.

“We’re the leftovers in this model!”

It’s a pretty convenient explanation.

But it’s not the only one.

He says an alternative hypothesis is that we’re living in a part of the Universe filled with matter — but other parts might be full of antimatter.

In other words, antimatter planets, antimatter stars or antimatter galaxies could be a thing.

“If we don’t find a difference between matter and antimatter, then that’s going to be the only remaining explanation,” Professor Doser says.

Unravelling this cosmic conundrum is what the researchers at CERN’s Antimatter Factory are trying to do.

But so far, this mysterious anti-stuff remains elusive. The team hasn’t found any other meaningful differences between matter and antimatter.

And if you’re concerned that this work doesn’t warrant fooling around with such a violently explosive anti-substance, Professor Doser says there’s no need to worry.

“We make such minute quantities that even if you were to destroy all the antimatter that we’re making in the course of a year, it wouldn’t be even enough to boil a cup of tea.”

ABC News, 19 February 2023

<https://abc.net.au>

Bulletin Board

Gossip

MAR. 03, 2023

New anti-corrosion polymer highlights damage, self-heals and is recyclable

2023-02-21

Engineers at ETH Zurich have developed a versatile new material that should help in the ongoing battle against corrosion for buildings and vehicles. The polymer coating not only protects against corrosion, but highlights cracks as they form, automatically repairs damage to itself, and can be recycled at the end of its life.

Corrosion will eventually affect pretty much everything humans build, from skyscrapers and bridges to planes, trains and automobiles. Developing new corrosion-resistant materials and coatings is a constant need, and now scientists have developed one with plenty of intriguing features.

The new material is called Poly(phenylene methylene), or PPM for short, and can be sprayed onto a surface where it hardens into a solid polymer coating. To test how well it performed as a barrier to corrosion, the team conducted an accelerated aging experiment where samples of aluminum alloy were exposed to a salty solution, either with or without a PPM coating. And sure enough, metals coated with 30- and 50-micrometer-thick layers of PPM showed no significant corrosion after many cycles of accelerated aging.

PPM also demonstrated a self-healing ability. When the team deliberately scratched the coating, then exposed it to the solution, it was found to quickly patch up the break on its own. This works because the solution reacts with the aluminum underneath, which causes the area to heat up and melt the polymer just enough to flow into the gap. Once filled, the contact between the solution and the metal is broken so it cools down, and the coating hardens once again.

The polymer gives advanced warning of this kind of damage too, in case human intervention is required. PPM fluoresces under UV light, but not if it’s damaged, allowing for a clear way to check for cracks that might otherwise be hard to spot.

Even at the end of its life, this overachieving material doesn’t stop – it can be recycled and applied to a new surface. By contrast, similar polymers can only be thrown into landfill or incinerated. In tests, the researchers removed and recycled it with only 5% loss of the material, and no drop in its performance even after five cycles of reuse.

Developing new corrosion-resistant materials and coatings is a constant need, and now scientists have developed one with plenty of intriguing features.

Bulletin Board

Gossip

MAR. 03, 2023

The researchers are currently applying for a patent for the material, while further work will investigate ways to improve the formula.

The research was published in the journal *Polymers*.

New Atlas, 21 February 2023

<https://newatlas.com>

1000x Faster: World's Fastest Laser Camera Films Combustion in Real Time

2023-02-23

By illuminating a sample surface with short laser beam pulses, it is possible to film sequences of various chemical and physical reactions. A research team that included researchers from the University of Gothenburg has now developed the world's fastest single-shot laser camera, which is at least a thousand times faster than today's most modern equipment for combustion diagnostics. The discovery has enormous significance for studying the lightning-fast combustion of hydrocarbons.

What happens to a material that is burned in different conditions? To investigate this question, researchers use a laser camera that photographs the material in a two-dimensional layer, known as LS CUP (single-shot laser sheet compressed ultrafast photography). By observing the sample from the side, it is possible to see what reactions and emissions occur over time and space. Researchers have used LS-CUP to study the combustion of various hydrocarbons.

12.5 billion images per second

Physicists from the University of Gothenburg, together with colleagues in the US and Germany, have developed an ultrafast laser camera that can create videos with a record-fast speed of 12.5 billion images per second, which is at least a thousand times faster than today's best laser equipment. This has enabled researchers to illustrate combustion with a time resolution that has never been achieved before.

"The more pictures taken, the more precisely we can follow the course of events. Hydrocarbon fuel combustion produces nano-sized soot particles, various light phenomena and polycyclic aromatic hydrocarbons, PAH, which are hazardous to the environment," says Yogeshwar Nath Mishra, who was one of the researchers at the University of Gothenburg and who is now presenting the results in a scientific article in the journal *Light: Science & Applications*.

Bulletin Board

Gossip

MAR. 03, 2023

Short-lived soot particles

Soot particles from hydrocarbons constitute 70% of the material in interstellar space and are also interesting nanomaterial with applications in electronics and energy. Soot particles and aromatic hydrocarbons are extremely short-lived, with a lifespan measured in nanoseconds when they burn up. Combustion is characterized by extremely fast reactions that are not repeated. Studying combustion requires ultrafast methods to capture images, which researchers have now achieved with this new laser camera.

"Before, problems arose when the camera was limited to a few million images per second. Producing two-dimensional pictures of different types of combustion has required repeated laser pulses, which impacts the combustion temperature when the laser adds energy," says Yogeshwar Nath Mishra.

Application in many research fields

The new laser camera takes a unique picture with a single laser pulse. The image speed is up to 10 billion pictures per second and can easily be adapted to observe all types of laser-induced signals throughout the particle's lifespan. Applications extend far beyond combustion research and can be used broadly in physics, chemistry, biology and medicine, energy and environmental research.

Sci Tech Daily, 23 February 2023

<https://scitechdaily.com>

Electrodes build themselves inside the bodies of live fish

2023-02-23

An injectable gel tested in living zebrafish can use the animals' internal chemistry to transform into a conductive polymer.

The discovery, reported on 23 February in *Science*¹, could lead to the development of electronic devices that can be implanted into body tissues such as the brain without causing harm.

When the gel is mixed with the recipient's own metabolites — chemicals generated by the body's processes — a chain reaction turns it into a solid but flexible material.

Substance that transforms into a conductive polymer using the body's own chemistry could improve implantable electronics.

Bulletin Board

Gossip

MAR. 03, 2023

“We are performing a lot of experiments with these materials to grow electrodes and electronics around cells,” says study co-author Magnus Berggren, a materials scientist at the Linköping University in Sweden. He adds that the work could ultimately improve technologies for deep-brain stimulation, for example, or help damaged nerves to regrow.

Internal electronics

Electronic devices or circuitry that can be implanted in the body have many potential applications in medicine and research, such as helping the brain to communicate with prosthetic limbs, or even enhancing memory. But conventional electronic materials can cause inflammation or scarring, and they often deteriorate inside living tissue and eventually stop working.

Although there has been progress towards developing soft, flexible electrodes, it is difficult to get them into the body in a non-invasive way, says Berggren. If you want to insert something deep into the brain, for example, “you will basically make it cut all the way through”, he says.

Berggren’s team wanted to create a material that was conductive, but stable in the long term, non-toxic and of a consistency that allows it to be injected.

The mixture they developed contains the chemical building blocks for a conductive polymer, along with enzymes. When injected into living tissue, the gel reacts with the common metabolites glucose and lactate, which causes the gel to polymerize into a much firmer — although still soft — material. Working with a group led by chemical biologist Roger Olsson at Lund University in Sweden, the researchers used this approach to generate polymer ‘electrodes’ inside the fins and brains of living zebrafish (*Danio rerio*). They also used it in the nervous tissue of leeches and in muscle tissue from chickens, pigs and cows.

Because the material doesn’t polymerize until it is inside the body, and is “compliant, soft and biocompatible”, it eliminates mechanical differences between typical electrode materials and living tissue that make some medical implants so invasive, says Timir Datta-Chaudhuri, an electrical engineer at the Feinstein Institutes for Medical Research in Manhasset, New York.

Alternative approach

The idea of using a living tissue’s chemistry to create a conducting material inside the body is not new. In 2020, researchers reported engineering an enzyme to be expressed in genetically modified neurons in the nematode

Bulletin Board

Gossip

MAR. 03, 2023

worm *Caenorhabditis elegans*. This caused the cells to produce conductive polymers².

That approach could not be used in people, says Sahika Inal, a bioengineer at the King Abdullah University of Science and Technology in Thuwal, Saudi Arabia. For her, the value of the latest research is that the gel reacts with substances that the body produces naturally, and it does not require the organism to be genetically modified. “I think this technology is providing alternative thinking. Instead of changing the same device’s software, why don’t we just completely get rid of that device and make the device inside the cell?”

There are still many barriers to be overcome before the injectable substance can be tested in people. Even though the polymer is highly conductive, for example, there is currently no way to make it functional by connecting it to an outside electricity source.

The researchers also need to do more tests to establish that the approach is safe. They didn’t observe any unusual behaviour in the zebrafish after injecting the solution into their brains, but they monitored the animals for only three days after the procedure. “They need to look at long-term chronic responses,” says Inal.

Nature, 23 February 2023

<https://nature.com>

Earth’s Russian nesting doll structure has a fifth layer we never knew about – the “innermost inner core”

2023-02-28

Geography textbooks will have to be re-written as scientists from the Australian National University (ANU) have confirmed that the Earth’s structure is made up of five, not four, layers.

We’ve all seen the cross-sectional diagrams of the Earth which show its four layers: the crust, the mantle, the outer core, and the inner core.

It seems these diagrams are incomplete.

In his 1864 science fiction novel, *The Journey to the Centre of the Earth*, about his own imaginings of what lies within our planet, Jules Verne wrote: “Science, my lad, has been built upon many errors; but they are errors which it was good to fall into, for they led to the truth.”

The discovery confirms a 20-year-old hypothesis.

Bulletin Board

Gossip

MAR. 03, 2023

While Verne's adventure story's proposed wondrous world full of life in the caverns of Earth's interior is not what we've found, his essential point remains cogent.

Seismologists at ANU used data from about 200 earthquakes of magnitude 6 or higher to dive deep into Earth's innards and rewrite what we thought we knew. Measuring the different speeds at which the waves travelled through the planet, the scientists were able to map out the Earth's inner structure and found that there is an additional distinct layer deep within.

This solid "metallic ball" sits within the inner core and is known as the "innermost inner core."

As the innermost inner core likely contains information from millions, even billions, of years ago, the discovery may help us understand how our planet formed.

"The existence of an internal metallic ball within the inner core, the innermost inner core, was hypothesised about 20 years ago," says ANU's Dr Thanh-Son Pham. "We now provide another line of evidence to prove the hypothesis."

"This inner core is like a time capsule of Earth's evolutionary history," adds Professor Hrvoje Tkalčić, also from ANU. "It's a fossilised record that serves as a gateway into the events of our planet's past. Events that happened on Earth hundreds of millions to billions of years ago."

When an earthquake occurs, its waves penetrate through the Earth, reaching the other side of the Earth before bouncing back – like a ping pong ball.

"By developing a technique to boost the signals recorded by densely populated seismograph networks, we observed, for the first time, seismic waves that bounce back-and-forth up to five times along the Earth's diameter. Previous studies have documented only a single antipodal bounce," Pham explains.

"The findings are exciting because they provide a new way to probe the Earth's inner core and its centremost region."

By analysing the variation of travel times of seismic waves, the scientists were able to infer the iron-nickel alloy structure within the inner core's innermost region is different to the outer layer.

Bulletin Board

Gossip

MAR. 03, 2023

"There are still many unanswered questions about the Earth's innermost inner core, which could hold the secrets to piecing together the mystery of our planet's formation," says Tkalčić.

The findings are published in Nature Communications.

Cosmos, 28 February 2023

<https://cosmosmagazine.com>

It's not just exercise that improves your mental health – intensity and type matters too

2023-02-28

Don't walk, run! At least that's what you should do if you want to give your mental health maximum benefit.

In a study of around 100 systemic reviews covering one thousand trials and nearly 130,000 participants, researchers at the University of South Australia found exercise had the largest benefits among those with disorders and diseases like depression.

People with other conditions like HIV, kidney disease, and pregnant and post-partum women were also found to draw positive mental health benefit from exercise.

While knowledge of the positive mental health exercise has been established for some time, this large-scale analysis has given scientists more precise insights into what makes it improve the mind. And they believe that health practitioners could be more specific when introducing exercise into a patient's conversation.

Although research is increasingly showing exercise as a viable component of mental health therapies, analysing many individual studies allowed the researchers to interrogate how different types of exercise may have benefits for specific groups.

According to lead author Dr Ben Singh, weight training was found to have a sizeable benefit for people with depression. For those with anxiety, movement-based exercises like yoga and Pilates were beneficial.

But exercising at higher intensity levels was found to deliver the greatest overall benefit to mental health.

A run around the block delivers you a psychological boost, but lifting weights might be more beneficial.

Bulletin Board

Gossip

MAR. 03, 2023

"Any intensity of exercise is beneficial, but our findings also show that if you can do slightly higher or greater intensities, that tends to be more beneficial," Singh said.

The findings demonstrate exercise as a potentially valuable tool for clinicians to consider when developing patient therapy.

But while exercise was found to have a bigger immediate impact over counselling and medication, Singh says those results should be interpreted cautiously.

Instead, exercise could provide another support to people, along with other common treatments.

"It provides evidence to say that exercise should be at least included in the conversation when health professionals and GPs are prescribing treatments for their patients," Singh says.

"So we don't want it to be replacing current treatments, such as medications or psychotherapy, because we do know that they can be effective and there's many individuals and many patients worldwide that benefit tremendously from medications and other forms of treatment.

"Exercise can be used in addition to those treatments as a first line form of care."

Cosmos, 28 February 2023

<https://cosmosmagazine.com>

Recycled Glass, Turned into Sand, Is Restoring Louisiana's Shrinking Coastline

2023-02-24

Most ideas that start over a bottle of wine don't go anywhere, but this one is different. Two Tulane University seniors in New Orleans, Franziska Trautmann and Max Steitz, were drinking wine in their dorm when they started lamenting the fact that the bottle would end up in landfill after they threw it in the trash. Trautmann, whose father immigrated to the US from rural Germany before she was born, had visited his home country and observed that Germany had a nationwide glass recycling program. Louisiana didn't.

"So we decided to be a part of the solution," Trautmann says matter-of-factly via Zoom from her office in New Orleans.

It's just one example of how pulverized glass has become an upcycling hero, finding new purpose in landscaping, construction, even coastal restoration.

Bulletin Board

Gossip

MAR. 03, 2023

With the moxie of youth, they simply started collecting glass bottles from fellow students and friends. After a local paper reported on their mission, the heaps of glass in their backyard grew so fast that they soon crowdfunded \$18,000 for a professional machine to pulverize glass into sand. "That's when we got really fired up," Trautmann says, "because people obviously cared about this."

Fast forward from their humble start in February 2020 to today, Steitz and Trautmann, both 25 years old, recycle about 100,000 pounds of glass every month at Glass Half Full Nola, a low-profit limited liability company whose primary purpose is to achieve a social benefit. So far, they have diverted 3.2 million pounds of glass from landfills with just eight employees.

They no longer collect the glass in their backyard, but have moved into a professional 40,000-square-foot facility in August 2020, with its own processing systems, forklifts and containers where the glass is sorted into different colors. Cooperating with a local glass blower and a jewelry designer, Andrew Barrows and Travis Laurendine, they started a jewelry shop, Nola Alchemy, that shows off the beauty of recycled glass that has been crafted into amulets and beads. "We're essentially turning trash into treasures," Trautmann says.

Much of the rest gets blasted into sand that can be used for landscaping and other purposes. "I didn't even know at the beginning that the main component of glass is silica, essentially sand!" Trautmann says, shaking her head. "When a hurricane is forecasted, we give burlap bags filled with glass-sand to residents for flood protection."

Glass Half Full has 12 glass collection containers throughout the city of New Orleans. They only ask the locals to clean the glass containers of food scraps before tossing them in; they don't need to remove labels and caps, "because the machine is able to separate the caps from the glass," Trautmann explains. Restaurants and other businesses can pay Glass Half Full to pick up their glass waste. Currently, 70 businesses have signed up, and 300 are on the waitlist as the young founders are scaling up. The enterprise does not turn a big profit, but according to Trautmann, they break even every month.

The problems Trautmann and Steitz are addressing are quite monumental: Each year, Americans throw away eight million tons of glass, a bulky part of landfills that can last centuries. The Environmental Protection Agency reports that less than a third of glass in the US gets recycled. And while more and more communities ban single-use plastic, glass bottles are only more environmentally friendly than plastic bottles if they get reused.

Bulletin Board

Gossip

MAR. 03, 2023

Other countries take recycling more seriously. Germany has a deposit system where breweries and other manufacturers take their containers back to clean and refill them. Before Germany introduced a mandatory markup of 25 cents to most containers in 2003, some three billion disposable beverage containers were dumped every year. Now, customers get the deposit refunded when they return the containers (which they can easily do in most supermarkets), and the country boasts a return rate of above 98 percent and a glass recycling rate of 76 percent.

Sweden has the best recycling rate of glass in the world. A highly centralized system ensures a 94 percent recycling rate as every glass container collected in the country is sent to one processing plant. Children in countries like Germany and Sweden are trained from young ages onward to recycle bottles, and collection containers are ubiquitous.

In the US, most citizens who don't happen to live in a community that offers glass recycling need to start their own initiative like Trautmann and Steitz did. The founders initially thought they would collect most glass bottles from restaurants and bars but after Covid led to the closure of most pubs, they had to change course. "We had to be flexible," Trautmann remembers. "In the end, Covid probably helped us because the bars were closed and most people drank at home. They had the time to collect the bottles and bring them to us, and most probably realized for the first time how much glass they use."

In Kansas City, the Boulevard Brewing Company saw a similar issue of a precious resource being wasted. "In 2009, Kansas Citians threw away 150 million pounds of perfectly good glass," the brewers note on their website. With the support of local companies and community organizations, they started Ripple Glass, distributed glass recycling bins throughout the metro area and built a processing plant. They repurpose the glass for fiberglass insulation and other uses.

A Rotary Club in Washington State wine country also pulverizes collected glass bottles into colorful sand for landscaping, playgrounds and water filters. So far, the 911 Glass Rescue Project has saved 320,000 pounds from landfills.

In Santa Fe, New Mexico, a married couple, Chris Bogle and Shelby Kaye, started Broken Arrow, a closed-loop system for glass recycling. Bogle is a glassblower and Kaye a trained sculptor. Together they use the recycled glass for creating handblown barware and art, but they also offer it to landscapers and gardeners. All true glassroots efforts.

Bulletin Board

Gossip

MAR. 03, 2023

The founders of Glass Half Full, though, found a particularly urgent need: They are using the glass to restore New Orleans' shrinking coastline. In the last decades, Louisiana has lost roughly the size of the state of Delaware, from its eroding beaches and marshes, and continues to lose the size of a football field every half hour due to erosion, hurricanes and rising sea levels.

Together with the Pointe au Chien Indian Tribe and Tulane University, with funding from the National Science Foundation, Trautmann and Steitz are working to restore some of the marshes at the Big Branch Marsh National Wildlife Refuge on the north shore of Lake Pontchartrain as part of their ReCoast initiative with the Coalition to Restore Coastal Louisiana (CRCL). There is actually a global sand shortage, and efforts to restore coastlines often involve dredging, which impacts ecosystems. Bolstered by a \$5 million grant from the National Science Foundation, scientists conducted tests to make sure the glass-sand is not harming the environment and no chemicals are leaching into the flora. Turns out that the natural sediment found along the Mississippi River Delta and most beaches along the Gulf Coast is mostly silica, just like the recycled glass.

So far, Glass Half Full has used 20 tons of glass each for two wetland restoration projects, including a wall with sand-filled burlap bags to trap sediment and help the fauna regrow. "In four short months, you can already see the huge accretion of sand and soil," the initiative reports. "The bulrush, typha and other marsh grasses are thriving in the newly created marshland!"

The conservationists are now looking into other areas along the Louisiana coast that might benefit from sand restoration, as the first project nationwide to do coastal restoration with recycled glass.

Trautmann and Steitz say they are proof that any individual can do something about climate change if they engage with their community. Needless to say they are doing great work. Or, more accurately, they are crushing it.

Reasons to be Cheerful, 24 February 2023

<https://reasonstobecheerful.world>

Bulletin Board

Curiosities

MAR. 03, 2023

Want to travel to Mars? Here's how long the trip could take.

2023-02-21

Despite what Star Trek's warp-speed journeys would have us believe, interplanetary travel is quite the hike. Take getting to Mars. Probes sent to the Red Planet by NASA and other space agencies spend about seven months in space before they arrive at their destination. A trip for humans would probably be longer—likely on the timescale of a few years.

There are a lot of things that a human crew needs to survive that robots don't, such as food, water, oxygen, and enough supplies for a return—the weight of which can slow down a spacecraft. With current technology, NASA calculations estimate a crewed mission to Mars and back, plus time on the surface, could take somewhere between two and three years. "Three years we know for sure is feasible," says Michelle Rucker, who leads NASA's Mars Architecture Team in the agency's Human Exploration and Operations Mission Directorate.

But NASA aims to shorten that timeline, in part because it would make a Mars mission safer for humans—we still don't know how well the human body can withstand the environment of space for an extended period. (The record for most consecutive days in space is 437.) The agency is investing in projects to develop new propulsion technologies that might enable more expeditious space travel.

A crooked path to Mars

In a science-fictional world, a spacecraft would blast off Earth and head directly to Mars. That trajectory would certainly make for a speedier trip. But real space travel is a lot more complicated than going from point A to point B.

"If you had all the thrust you want, you could ignore the fact that there happens to be gravity in our universe and just plow all the way through the solar system," says Mason Peck, a professor of astronautics at Cornell University who served as NASA's chief technologist from 2011 to 2013. "But that's not a scenario that's possible right now."

Such a direct trajectory has several challenges. As a spacecraft lifts off Earth, it needs to escape the planet's gravitational pull, which requires quite a bit of thrust. Then, in space, the force of gravity from Earth, Mars, and the sun pulls the spacecraft in different directions. When it is far

Bulletin Board

Curiosities

MAR. 03, 2023

enough away, it will settle into orbit around the sun. Bucking that gravity requires fuel-intensive maneuvers.

The second challenge is that the planets do not stay in a fixed place. They orbit the sun, each at its own rate: Mars will not be at the same distance from Earth when the spacecraft launches as the Red Planet will be, say, seven months later.

As such, the most fuel-efficient route to Mars follows an elliptical orbit around the sun, Peck says. Just one-way, that route covers hundreds of millions of miles and takes over half a year, at best.

But designing a crewed mission to the Red Planet isn't just about figuring out how fast a spacecraft can get there and back. It's about "balance," says Patrick Chai, in-space propulsion lead for NASA's Mars Architecture Team. "There are a whole bunch of decisions we have to make in terms of how we optimize for certain things. Where do we trade performance for time?" Chai says. "If you just look at one single metric, you can end up making decisions that are really great for that particular metric, but can be problematic in other areas."

One major trade-off for speed has to do with how much stuff is on board. With current technology, every maneuver to shorten the trip to Mars requires more fuel.

If you drive a car, you know that in order to accelerate the vehicle, you step on the gas. The same is true in a spacecraft, except that braking and turning also use fuel. To slow down, for instance, a spacecraft fires its thrusters in the opposite direction to its forward motion.

But there are no gas stations in space. More fuel means more mass on board. And more mass requires more fuel to propel that extra mass through the air... and so on. Trimming a round-trip mission down to two years is when this trade-off starts to become exponentially less efficient, Rucker says. At least, that's with current technology.

New tech to speed up the trip

NASA would like to be able to significantly reduce that timeline. In 2018, the space agency requested proposals for technological systems that could enable small, uncrewed missions to fly from Earth to Mars in 45 days or less.

At the time, the proposals didn't gain much traction. But the challenge inspired engineers to design innovative propulsion systems that don't

Nuclear engines or not, you're gonna need a lot of PTO to get to the Red Planet.

Bulletin Board

Curiosities

MAR. 03, 2023

yet exist. And now, NASA has begun to fund the development of leading contenders. In particular, the space agency has its eye on nuclear propulsion.

Spacecraft currently rely largely on chemical propulsion. “You basically take an oxidizer and a fuel, combine them, and they combust, and that generates heat. You accelerate that heated product through a nozzle to generate thrust,” explains NASA’s Chai.

Engineers have known for decades that a nuclear-based system could generate more thrust using a significantly smaller amount of fuel than a chemical rocket. They just haven’t built one yet—though that might be about to change.

One of NASA’s nuclear investment projects aims to integrate a nuclear thermal engine into an experimental spacecraft. The Demonstration Rocket for Agile Cislunar Operations, or DRACO, program, is a collaboration with the Defense Advanced Research Projects Agency (DARPA), and aims to demonstrate the resulting technology as soon as 2027.

The speediest trip to Mars might come from another project, however. This concept, the brainchild of researchers at the University of Florida and supported by a NASA grant, seeks to achieve what Chai calls the “holy grail” of nuclear propulsion: a combination system that pairs nuclear thermal propulsion with an electric kind.

“We did some preliminary analysis, and it seems like we can get pretty close to [45 days],” says the leader of that project, Ryan Gosse, a professor of practice in the University of Florida’s in-house applied research program, Florida Applied Research in Engineering (FLARE). One caveat: That timeline is for a light payload and no humans on board. However, if the project is successful, the technology could potentially be scaled up in the future to support a crewed mission.

There are two types of nuclear propulsion, and both have their merits. Nuclear thermal propulsion, which uses heat, can generate a lot of thrust quickly from a small amount of fuel. Nuclear electric propulsion, which uses charged particles, is even more fuel-efficient but generates thrust much more slowly.

“While you’re in deep space, the electric propulsion is really great because you have all the time in the world to thrust. The efficiency, the miles per gallon, is far, far superior than the high-thrust,” Chai says. “But when you’re around planets, you want that oomph to get you out of the gravity well.”

Bulletin Board

Curiosities

MAR. 03, 2023

The challenge, however, is that both technologies currently require different types of nuclear reactors, says Gosse. And that means two separate systems, which reduces the efficiency of having a nuclear propulsion system. So Gosse and his team are working to develop technology that can use the one system to generate both types of propulsion.

NASA’s Mars architecture team is also working with a bimodal concept that uses a chemical propulsion system to maneuver around planets and solar-powered electric propulsion to do the thrusting in deep space.

“What we are developing is different tools for the toolbox,” says NASA’s Rucker. “One tool isn’t going to be enough to do all of the exploration that we want to do. So we’re working on all of these.”

Popular Science, 21 February 2023

<https://popsci.com>

How do bats live with so many viruses? New bat stem cells hint at an answer

2023-02-21

Compared with other mammals, bats are notorious for hosting more viruses that are dangerous to people but not themselves. It’s an oddity that’s drawn renewed attention since COVID-19 broke out in humans—many scientists suspect the coronavirus SARS-CoV-2 leaped from bats into people, directly or via an intermediate host. Seeking to create large quantities of bat tissue to help study why the flying animals are so virus-friendly, a research team now reports it has transformed adult bat cells into versatile stem cells that can be coaxed to form many kinds of tissue.

The advance, described today in *Cell*, thrills many bat scientists. “If the work in this paper can be (easily) reproduced in other groups with different bat species, the impact will be huge!” says Linfa Wang, a bat coronavirus researcher at the Duke-NUS Medical School in Singapore. And early studies of the bat stem cells have already suggested the animals may not only tolerate viruses, but actually let them remain active, possibly because doing so has some advantage for the hosts.

The new work traces back to the spring of 2020. As the COVID-19 pandemic started, Thomas Zwaka, a stem cell researcher at the Icahn School of Medicine at Mount Sinai, became fascinated by the question of why bats carry so many viruses that can cause human disease. But

Research team hits on formula to create stem cells from tissue of adult.

Bulletin Board

Curiosities

MAR. 03, 2023

researchers studying this question have been hampered by the fact that getting bat samples to study in the lab is difficult. “Even with a breeding colony [like our team has], it is still a challenge to get sufficient bat cells reliably and reproducibly for certain types of research,” Wang says.

To sidestep that problem, Zwaka wanted to create bat stem cells that could be kept in the lab and be differentiated, as needed, into specific kinds of tissue. Some researchers had claimed years before to have done this, but the work had never been reproduced.

But with much of the world shut down by COVID-19, Zwaka first had to figure out how to get some bat tissue delivered to his laboratory. Javier Juste, an evolutionary biologist at the Spanish National Research Council, eventually agreed to send Zwaka some samples from a colony of greater horseshoe bats he was studying in Seville. To have fresh tissue that could survive the long flight, Juste prepared the bat samples at the airport in Madrid just before they were loaded on one of the few planes still crossing the Atlantic Ocean. In his New York City lab, Zwaka then tried to use a strategy developed in 2006 by Japanese researcher Shinya Yamanaka to force adult mammalian cells back into an earlier, stem cell–like state. But the recipe for creating these induced pluripotent stem (iPS) cells did not work on the bat samples.

After months of tweaking the formula, however, Zwaka and his colleagues finally found a combination of factors that worked. Several tests, including differentiating the transformed bat cells into multiple types of cells, suggested they were indeed pluripotent cells. The researchers then repeated the procedure with cells from a different bat species, the greater mouse-eared bat, with similar results. “The two bats are evolutionarily very distant,” Zwaka says. “So this told us that our protocol probably works with many different bats.”

In studying these cells, Zwaka’s team noticed something interesting. Certain viruses can insert versions of their genes into the genomes of human or mouse cells, and these viral sequences sometimes reawaken in cells that are in a pluripotent state. And when Zwaka and colleagues looked for remnants of these viral sequences in the bat iPS cells, they found numerous active versions—as well as some proteins that these sequences produce.

“It’s just striking how many of these virus sequences there are,” says Zwaka, who proposes that bats don’t restrain these active sequences because their replication may act as a defense strategy against other viruses or as a kind of self-vaccination.

Bulletin Board

Curiosities

MAR. 03, 2023

That remains speculation for now, other bat researchers caution. Scientists have proposed before that viruses and bats have a symbiotic relationship, Wang says, but it is hard to prove.

Indeed, Kevin Olival, a bat researcher at the EcoHealth Alliance, a nonprofit research group based in New York City, says the data in the new Cell paper are too limited to conclude that bat stem cells are special in how they handle the integrated, or endogenous, viral sequences. But he thinks the new stem cell technique could help conduct similar sequence-hunting studies in a wide range of other mammals, “and see if bats really are above average in this sense.”

Bat scientists, meanwhile, are enthusiastic about finally having a recipe for creating bat iPS cells. “We are already discussing in my team how to make use of these pluripotent cells,” says Vincent Munster, a virologist at the U.S. National Institute of Allergy and Infectious Diseases. “This is a terrific paper,” adds Jacob Hanna, a stem cell researcher at the Weizmann Institute of Science. “Undoubtedly this is going to become a widely used platform.”

Science, 21 February 2023

<https://science.org>

How Widespread Are These Toxic Chemicals? They’re Everywhere.

2023-02-22

Polar bears in the Arctic and plankton in the Pacific. Cardinals in Atlanta and crocodiles in South Africa.

While concern about PFAS compounds, also known as “forever chemicals” because they break down very slowly, has largely focused on people, the pollutants have also been detected in wildlife. Now, a review of research made public on Wednesday by the Environmental Working Group, a nonprofit advocacy organization that focuses on environmental safety, shows PFAS turning up in hundreds of wild animal species around the world.

In people, some of these chemicals are linked to cancers, developmental issues, reduced immune function, hormonal interference and heightened cholesterol. Last year, the Environmental Protection Agency found there was virtually no safe level in humans for two of the most widely used PFAS chemicals and proposed designating them as hazardous.

Researchers created a map showing where PFAS compounds, linked to cancer in humans, have been detected in wildlife. It spans the globe.

Bulletin Board

Curiosities

MAR. 03, 2023

To get a sense of contamination in wildlife, researchers at the Environmental Working Group reviewed more than a hundred studies and created a map from their survey.

“We were like, ‘Holy smokes, this is shocking,’” said David Andrews, a senior scientist at the organization who worked on the review, recalling his team’s surprise at the sheer number and spread of studies documenting contamination.

With many wild animal and plant species already staggering under a worsening biodiversity crisis driven by habitat loss, hunting and fishing, climate change and other pressures, scientists say they are increasingly worried about the added burden of PFAS contamination.

“These chemicals are likely serving as an additional stressor,” Dr. Andrews said.

Scientists are only beginning to understand that dynamic. One study found that concentrations of PFAS in endangered sea turtles correlated with reduced ability to hatch. Others have found levels in dolphins that compare to those in workers who have been occupationally exposed.

Most Americans have PFAS in their blood, according to the federal government. The chemicals are found in a variety of consumer products, including nonstick cookware, waterproof clothes and stain-resistant fabrics. They are being phased out in food packaging.

Formally called perfluoroalkyl and polyfluoroalkyl substances, the chemicals are created by fusing fluorine and carbon atoms to create a compound that doesn’t exist naturally. Because many of these chemicals break down very slowly, they tend to accumulate up the food chain.

Manufacturers counter that not all PFAS compounds are the same.

“It is not scientifically accurate or appropriate to group this vast family of solid, liquid and gaseous substances into a one-size-fits-all class,” said Tom Flanagan, a spokesman for the American Chemistry Council.

The Environmental Protection Agency says research is continuing to better understand the potential harm of all kinds of PFAS compounds.

Researchers working in the field already knew them to be widespread in wildlife.

“PFAS are everywhere and in most animals surveyed,” said Rainer Lohmann, a professor of oceanography at the University of Rhode

Bulletin Board

Curiosities

MAR. 03, 2023

Island who focuses on PFAS contamination and was not involved in the Environmental Working Group’s review. “But collecting that information and putting it together is a huge effort. And I am not sure the general public is fully aware how thoroughly these chemicals have penetrated the environment.”

Dr. Lohmann noted that areas on the map that seem to have less contamination — Africa, South America and much of Asia — probably just appear that way because of a lack of studies conducted in those places.

The map of global PFAS contamination would be even more dramatic and revealing, he said, if it included plants and algae.

New York Times, 22 February 2023

<https://nytimes.com>

Life Mystery Solved: What Determines the Lifespan of a Tree Leaf?

2023-02-21

How long will a leaf live? It’s an economic decision.

The leaves of Monkey Puzzle trees have a lifespan of more than 20 years, while Picea trees growing in the Gongga Mountains in China can survive for millennia. Despite growing in harsh conditions, these trees grow slowly, and their leaves typically last an average of 20 years.

In contrast, maple leaves survive for only one season, while blueberry leaves have a lifespan of a mere three months.

So, what determines the lifespan of a tree leaf?

The answer to that superficially simple question is reported today in a paper in Science Advances by an international team of researchers from China, the UK, Japan, Norway, USA, and Australia.

“It’s all about the economic choices faced by plants,” says first author, Dr. Han Wang from Tsinghua University in Beijing.

“We already knew that conifers and other evergreen trees make longer-living leaves the closer they are to the poles,” she says. “Deciduous trees do the opposite. Their longest-lasting leaves are found in the tropics.”

“And we knew that long-lived leaves tend to be tougher and thicker, and more expensive to build.”

The researchers expect the new findings to improve global and regional climate models, aid in forest and vegetation management, and provide more accurate predictions on crop yield and climate change’s impact on agriculture.

Bulletin Board

Curiosities

MAR. 03, 2023

“Now, we have identified the major environmental factors at play, and summarised them in two equations,” she says. “These leaf economic traits are fundamental to the carbon cycle and nutrient economy.”

The team tested their equations using data from thousands of species from hundreds of ecosystems, drawn from the China Plant Trait Database and the Global Plant Trait Network.

“Each species is essentially taking a punt on the best way to maximize carbon absorption,” says co-author Professor Ian Wright from Macquarie University and Western Sydney University.

“Evergreen conifers growing in poor soil in areas with a long cold winter can only thrive if they make long-term investments in their leaves. Whereas deciduous trees, like the maple, race to create new leaves and capture carbon in the summer sun before leaf-drop in autumn,” he says. “The economically rational decision for a maple tree is to invest in fast-growing, cheap but flimsy leaves.”

Plants have been subject to profound changes in climate during their evolution. Glaciation and other large, and sometimes rapid, changes in recent geological times have resulted in major changes in vegetation. The human impact on climate and direct impact on vegetation are adding to the forces shaping plant communities, in ways that remain only partly understood.

The researchers propose that this research will not only explain what grows where today, but it will also move ecology into a predictive science that will:

- enable better, more accurate global and regional climate models
- allow land managers to better model forests and other vegetation, and predict how climate change will affect ecosystems
- allow better estimation of crop yield and the impact of climate change on agriculture.

Reference: “Leaf economics fundamentals explained by optimality principles” by Han Wang, I. Colin Prentice, Ian J. Wright, David I. Warton, Shengchao Qiao, Xiangtao Xu, Jian Zhou, Kihachiro Kikuzawa and Nils Chr. Stenseth, 18 January 2023, Science Advances.

DOI: 10.1126/sciadv.add5667

The paper builds on twenty years of research led by Professor Mark Westoby and Professor Ian Wright at Macquarie University.

Bulletin Board

Curiosities

MAR. 03, 2023

Their 2004 paper in Nature, ‘The World-wide leaf economics spectrum’ has been cited over 7,500 times and has been followed by papers on leaf photosynthetic capacity, leaf respiration costs, leaf nitrogen concentration, leaf size, and now, leaf lifespan.

“This body of work has transformed ecology,” says Professor Nathan Hart, Head of Macquarie University’s School of Natural Sciences. “It’s also key to ongoing work by Macquarie researchers on the impact of plant invasions, the resilience of horticultural species to climate change, and the form and function of plant species on the thousands of islands that surround the Australian mainland.”

The study was funded by the National Natural Science Foundation of China, the Schmidt Family Foundation, the Horizon 2020 Framework Programme, and the Australian Research Council.

Sci Tech Daily, 21 February 2023

<https://scitechdaily.com>

E. coli bacteria turned into nanowire factory for artificial nose

2023-02-23

The mighty snouts on dogs are famously known for their abilities to sniff out everything from disease to explosives, but science is quickly catching up with its own range of artificial noses. Now, in the most recent breakthrough in this exciting field, researchers have used genetically modified E. coli bacteria to spin electrically conductive nanowires capable of detecting the odor molecules created by kidney disease. What’s more, they say their microbial manufacturing plant can be tuned to create other wires to pick up even more medical conditions.

When it comes to sensing the world around us through our noses, humans fall well short of our canine companions. In an effort to catch up though, scientists have been hard at work over the years, creating a dizzying array of artificial odor sensors. We’ve seen man-made “noses” that can find cancer in blood or urine samples, detect Parkinson’s disease from skin odor, pick up on bacteria in water, find people buried beneath rubble from a natural disaster, and sniff out dangerous toxins in the air.

The problem with many of the nanowires used in these sensors, say researchers at the University of Massachusetts Amherst (UMA), is that they are made from toxic and non-biodegradable materials such as silicon or

Nanowires grown from bacteria have found their way onto sensors that act as an artificial nose to sniff out kidney disease.

Bulletin Board

Curiosities

MAR. 03, 2023

carbon fiber. To tackle this issue, the research team turned to a bacterial solution.

Last year, UMA microbiologist Derek Lovley and electrical and computer engineer Jun Yao used a bacteria called *Geobacter sulfurreducens* to create a wearable biofilm that generates electricity from sweat. The success of that experiment centered on the bacteria's ability to grow extremely small wires that can actually conduct electricity. The team decided to put those nanowires to work in their new artificial nose.

However, *G. sulfurreducens* is hard to culture, as it requires very particular conditions in which to thrive. So, the team enlisted the help of a much more hardy bacteria.

"What we've done," says Lovley, "is to take the 'nanowire gene' – called pilin – out of *G. sulfurreducens* and splice it into the DNA of *Escherichia coli*, one of the most widespread bacteria in the world."

In addition to getting *E. coli* to start producing nanowires, Lovley and Yao also performed an additional genetic modification that caused those wires to become coated with a peptide known as DLESFL. This made the wires 100 times more sensitive than they were before to ammonia, a byproduct found in the breath of those with kidney disease. The bio wires were then implanted onto a sensor which was more effective at spotting the ammonia than previous sensors made from traditional materials.

"One of the most exciting things about this line of research is that we're taking electrical engineering in a fundamentally new direction," said Yao. "Instead of wires made from scarce raw resources that won't biodegrade, the beauty of these protein nanowires is that you can use life's genetic design to build a stable, versatile, low impact and cost-effective platform."

The researchers say the tiny bacterial factories could be made to produce wires coated in different peptides that could sense for the chemical makers of other diseases.

"It's possible to design unique peptides, each of which specifically binds a molecule of interest," said study co-author Toshiyuki Ueki. "So, as more tracer molecules emitted by the body and which are specific to a particular disease are identified, we can make sensors that incorporate hundreds of different chemical-sniffing nanowires to monitor all sorts of health conditions."

Bulletin Board

Curiosities

MAR. 03, 2023

The research has been published in the journal *Biosensors and Bioelectronics*.

New Atlas, 23 February 2023

<https://newatlas.com>

Astronomers Discover Bizarre "Forbidden" Planet That Should Not Exist

2023-02-25

A team of astronomers has discovered an unusual planetary system in which a large gas giant planet orbits a small red dwarf star called TOI-5205. Their findings challenge long-held ideas about planet formation. Led by Shubham Kanodia from the Carnegie Institution for Science, the researchers published their findings in *The Astronomical Journal*.

Smaller and cooler than our Sun, M dwarfs are the most common stars in our Milky Way galaxy. Due to their small size, these stars tend to be about half as hot as the Sun and much redder. They have very low luminosities, but extremely long lifespans. Although red dwarfs host more planets, on average, than other, more massive types of stars, their formation histories make them unlikely candidates to host gas giants.

The newly discovered planet—TOI 5205b—was first identified as a potential candidate by NASA's Transiting Exoplanet Survey Satellite (TESS). Kanodia's team, which included Carnegie's Anjali Piette, Alan Boss, Johanna Teske, and John Chambers, then confirmed its planetary nature and characterized it using a variety of ground-based instruments and facilities.

"The host star, TOI-5205, is just about four times the size of Jupiter, yet it has somehow managed to form a Jupiter-sized planet, which is quite surprising!" exclaimed Kanodia, who specializes in studying these stars, which comprise nearly three-quarters of our galaxy yet can't be seen with the naked eye. He also wrote a blog post about the discovery.

A small number of gas giants have been discovered orbiting older M dwarf stars. But until now no gas giant has been found in a planetary system around a low-mass M dwarf like TOI-5205. To grasp the size comparison here, a Jupiter-like planet orbiting a Sun-like star could be compared to a pea going around a grapefruit; for TOI-5205b, because the host star is so much smaller, it is more like a pea going around a lemon. In fact, when the

"Forbidden" planet orbiting small star challenges gas giant formation theories.

Bulletin Board

Curiosities

MAR. 03, 2023

Jupiter-mass TOI 5205b crosses in front of its host, it blocks about seven percent of its light—one of the largest known exoplanet transits.

Planets are born in the rotating disk of gas and dust that surrounds young stars. The most commonly used theory of gas planet formation requires about 10 Earth masses of this rocky material to accumulate and form a massive rocky core, after which it rapidly sweeps up large amounts of gas from the neighboring regions of the disk to form the giant planet we see today.

The time frame in which this happens is crucial.

“TOI-5205b’s existence stretches what we know about the disks in which these planets are born,” Kanodia explained. “In the beginning, if there isn’t enough rocky material in the disk to form the initial core, then one cannot form a gas giant planet. And at the end, if the disk evaporates away before the massive core is formed, then one cannot form a gas giant planet. And yet TOI-5205b formed despite these guardrails. Based on our nominal current understanding of planet formation, TOI-5205b should not exist; it is a “forbidden” planet.”

The team demonstrated that the planet’s very large transit depth makes it extremely conducive for future observations with the recently launched JWST, which could shed some light on its atmosphere and offer some additional clues about the mystery of its formation.

Sci Tech Daily, 25 February 2023

<https://scitechdaily.com>

Engineered wood gets stronger while trapping CO2

2023-02-23

Structural materials like steel or cement come at a high cost both in dollars and carbon dioxide emissions; building construction and use accounts for an estimated 40% of emissions. Developing sustainable alternatives to existing materials could help mitigate climate change and reduce carbon dioxide emissions.

Working to address both issues at once, researchers found a way to incorporate molecules of a carbon dioxide-trapping crystalline porous material into wood.

“Wood is a sustainable, renewable structural material that we already use extensively,” says Muhammad Rahman, assistant research professor in

Bulletin Board

Curiosities

MAR. 03, 2023

materials science and nanoengineering at Rice University. “Our engineered wood did exhibit greater strength than normal, untreated wood.”

To achieve the feat, the network of cellulose fibers that gives wood its strength is first cleared out through a process known as delignification.

“Wood is made up of three essential components: cellulose, hemicellulose, and lignin,” Rahman says. “Lignin is what gives wood its color, so when you take lignin out, the wood becomes colorless. Removing the lignin is a fairly simple process that involves a two-step chemical treatment using environmentally benign substances. After removing the lignin, we use bleach or hydrogen peroxide to remove the hemicellulose.”

Next, the delignified wood is soaked in a solution containing microparticles of a metal-organic framework, or MOF, known as Calgary framework 20 (CALF-20). MOFs are high-surface-area sorbent materials used for their ability to adsorb carbon dioxide molecules into their pores.

“The MOF particles easily fit into the cellulose channels and get attached to them through favorable surface interactions,” says Soumyabrata Roy, a research scientist and lead author of the study in Cell Reports Physical Science.

MOFs are among several nascent carbon capture technologies developed to address anthropogenic climate change.

“Right now, there is no biodegradable, sustainable substrate for deploying carbon dioxide-sorbent materials,” Rahman says. “Our MOF-enhanced wood is an adaptable support platform for deploying sorbent in different carbon dioxide applications.”

“Many of the existing MOFs are not very stable in varying environmental conditions,” Roy says. “Some are very susceptible to moisture, and you don’t want that in a structural material.”

CALF-20, however, developed by George Shimizu, a professor at the University of Calgary, and his collaborators, stands out in terms of both performance level and versatility under a variety of environmental conditions, Roy says.

“The manufacturing of structural materials such as metals or cement represents a significant source of industrial carbon emissions,” Rahman says. “Our process is simpler and ‘greener’ in terms of both substances used and processing byproducts.”

A new engineered wood traps carbon dioxide through a potentially scalable, energy-efficient process that also makes the material stronger for use in construction.

Bulletin Board

Curiosities

MAR. 03, 2023

“The next step would be to determine sequestration processes as well as a detailed economic analysis to understand the scalability and commercial viability of this material,” he adds.

Shell Technologies and the UES-Air Force Research Laboratory supported the research.

Futurity, 23 February 2023

<https://futura.org>

Physicists give the first law of thermodynamics a makeover

2023-02-22

West Virginia University physicists have made a breakthrough on an age-old limitation of the first law of thermodynamics.

Paul Cassak, professor and associate director of the Center for KINETIC Plasma Physics, and graduate research assistant Hasan Barbhuiya, both in the Department of Physics and Astronomy, are studying how energy gets converted in superheated plasmas in space.

Their findings, published in *Physical Review Letters*, will revamp scientists' understanding of how plasmas in space and laboratories get heated up, and may have a wide variety of further applications across physics and other sciences.

The first law of thermodynamics states that energy can neither be created nor destroyed, but it can be converted into different forms.

“Suppose you heat up a balloon,” Cassak said. “The first law of thermodynamics tells you how much the balloon expands and how much hotter the gas inside the balloon gets. The key is that the total amount of energy causing the balloon to expand and the gas to get hotter is the same as the amount of heat you put into the balloon. The first law has been used to describe many things—including how refrigerators and car engines work. It’s one of the pillars of physics.”

Developed in the 1850s, the first law of thermodynamics is only valid for systems in which a temperature can be properly defined, a state known as equilibrium. As an example, when combined, a cup of cold water and a cup of hot water will eventually reach a warm temperature between them. This warm temperature is the equilibrium. However, when the hot

Bulletin Board

Curiosities

MAR. 03, 2023

and cold water have not yet reached that endpoint, the water is out of equilibrium.

Likewise, in many areas of modern science, systems are not in equilibrium. For over 100 years, researchers have attempted to expand the first law for common materials not in equilibrium, but such theories only work when the system is nearly there—when the hot and cold water are almost mixed. The theories do not work, for example, in space plasmas, which are far from equilibrium.

The work of Cassak and Barbhuiya fills in the blanks on this limitation.

“We generalized the first law of thermodynamics for systems that are not in equilibrium,” Cassak said. “We did a pencil and paper calculation to find how much energy is associated with matter not being in equilibrium, and it works whether the system is close to or far from equilibrium.”

Their research has numerous potential applications. The theory will help scientists understand plasmas in space, which is important for preparing for space weather. Space weather occurs when huge eruptions in the solar atmosphere blast superheated plasma into space. It can cause problems like power outages, interruptions to satellite communications and the rerouting of airplanes.

“The result represents a really large step of our understanding,” Cassak said. “Until now, the state-of-the-art in our research area was to account for energy conversion only associated with expansion and heating, but our theory provides a way to calculate all the energy from not being in equilibrium.”

“Because the first law of thermodynamics is so widely used,” Barbhuiya said, “it is our hope that scientists in a wide array of fields could use our result.”

For example, it may be useful for studying low-temperature plasmas—which are important for etching in the semiconductor and circuit industry—as well as in other areas like chemistry and quantum computing. It might also help astronomers study how galaxies evolve in time.

Groundbreaking research related to Cassak and Barbhuiya’s is being carried out in PHASMA, the PHase Space MApping experiment, in the WVU Center for KINetic Experimental, Theoretical and Integrated Computational Plasma Physics.

The theory will help scientists understand plasmas in space, which is important for preparing for space weather.

Bulletin Board

Curiosities

MAR. 03, 2023

"PHASMA is making space-relevant measurements of energy conversion in plasmas that are not in equilibrium. These measurements are totally unique worldwide," Cassak said.

Likewise, the breakthrough he and Barbhuiya have made will change the landscape of plasma and space physics, a feat that doesn't happen often.

"There aren't many laws of physics—Newton's laws, the laws of electricity and magnetism, the three laws of thermodynamics, and the laws of quantum mechanics," said Duncan Lorimer, professor and interim chair of the Department of Physics and Astronomy. "To take one of these laws that has been around over 150 years and improve on it is a major achievement."

"This new first principles result in non-equilibrium statistical mechanics as applied to plasmas is a great example of the academic research enabled by NSF's mission 'to promote the progress of science,'" said Vyacheslav Lukin, a program director for plasma physics in the NSF Division of Physics.

Phys Org, 22 February 2023

<https://phys.org>

NASA has good news for people who like the idea of being alive

2023-03-01

Last year, a collaboration between NASA and Johns Hopkins University's Applied Physics Laboratory smashed a US\$300 million spaceship into an asteroid about 11 million kilometres from Earth.

Now, they know they could do it again, but with Earth-saving potential.

At the time of the impact the DART (Double Asteroid Redirection Test) project was considered a raging success.

By using the impact of the spacecraft at over 26,000 km/h to 'nudge' asteroid Dimorphos' orbit closer to its parent Didymos, NASA and the APL hoped to prove planetary defence using kinetic energy transference was possible.

Having set an orbit reduction target of seven minutes to confirm the success of their mission. The new orbital path was found to be 33 minutes shorter than before the impact.

Snooker-style space impacts a viable way to defend against asteroids.

Bulletin Board

Curiosities

MAR. 03, 2023

Among the five project articles published in leading science journal Nature, researchers are now confident in the ability to use kinetic impact to knock threatening asteroids off course.

While no known asteroids are expected to pose a threat to Earth for at least 100 years, the success of the DART mission has NASA optimistic about the future prospects of planetary defence.

The fact that the satellite was launched directly into the Dimorphos asteroid without 'reconnaissance' prior to impact, was also not seen to be problematic for future attempts to redirect space bodies.

However they did affirm that prior knowledge of a potentially deadly asteroid impact would be particularly helpful for avoiding a fate akin to the dinosaurs, noting "kinetic impactor technology for asteroid deflection requires having sufficient warning time – at least several years but preferably decades—to prevent an asteroid impact with the Earth."

"DART's successful autonomous targeting of a small asteroid with limited prior knowledge is a key first accomplishment on the path to advancing kinetic impactor technology to an operational capability," they said.

"This first successful step to demonstrate the viability of kinetic impactor technology for planetary defence builds optimism about humanity's capacity to protect the Earth from an asteroid threat."

Cosmos, 1 March 2023

<https://cosmosmagazine.com>

Will future computers run on human brain cells?

2023-02-28

The team outlines their plan for "organoid intelligence" today in the journal Frontiers in Science.

"Computing and artificial intelligence have been driving the technology revolution but they are reaching a ceiling," said Thomas Hartung, a professor of environmental health sciences at the Johns Hopkins Bloomberg School of Public Health and Whiting School of Engineering who is spearheading the work. "Biocomputing is an enormous effort of compacting computational power and increasing its efficiency to push past our current technological limits."

For nearly two decades scientists have used tiny organoids, lab-grown tissue resembling fully grown organs, to experiment on kidneys, lungs,

A 'biocomputer' powered by human brain cells could be developed within our lifetime, according to researchers.

Bulletin Board

Curiosities

MAR. 03, 2023

and other organs without resorting to human or animal testing. More recently Hartung and colleagues at Johns Hopkins have been working with brain organoids, orbs the size of a pen dot with neurons and other features that promise to sustain basic functions like learning and remembering.

“This opens up research on how the human brain works,” Hartung said. “Because you can start manipulating the system, doing things you cannot ethically do with human brains.”

Hartung began to grow and assemble brain cells into functional organoids in 2012 using cells from human skin samples reprogrammed into an embryonic stem cell-like state. Each organoid contains about 50,000 cells, about the size of a fruit fly’s nervous system. He now envisions building a futuristic computer with such brain organoids.

Computers that run on this “biological hardware” could in the next decade begin to alleviate energy-consumption demands of supercomputing that are becoming increasingly unsustainable, Hartung said. Even though computers process calculations involving numbers and data faster than humans, brains are much smarter in making complex logical decisions, like telling a dog from a cat.

“The brain is still unmatched by modern computers,” Hartung said. “Frontier, the latest supercomputer in Kentucky, is a \$600 million, 6,800-square-foot installation. Only in June of last year, it exceeded for the first time the computational capacity of a single human brain -- but using a million times more energy.”

It might take decades before organoid intelligence can power a system as smart as a mouse, Hartung said. But by scaling up production of brain organoids and training them with artificial intelligence, he foresees a future where biocomputers support superior computing speed, processing power, data efficiency, and storage capabilities.

“It will take decades before we achieve the goal of something comparable to any type of computer,” Hartung said. “But if we don’t start creating funding programs for this, it will be much more difficult.”

Organoid intelligence could also revolutionize drug testing research for neurodevelopmental disorders and neurodegeneration, said Lena Smirnova, a Johns Hopkins assistant professor of environmental health and engineering who co-leads the investigations.

Bulletin Board

Curiosities

MAR. 03, 2023

“We want to compare brain organoids from typically developed donors versus brain organoids from donors with autism,” Smirnova said. “The tools we are developing towards biological computing are the same tools that will allow us to understand changes in neuronal networks specific for autism, without having to use animals or to access patients, so we can understand the underlying mechanisms of why patients have these cognition issues and impairments.”

To assess the ethical implications of working with organoid intelligence, a diverse consortium of scientists, bioethicists, and members of the public have been embedded within the team.

Science Daily, 28 February 2023

<https://sciencedaily.com>

Bulletin Board

Technical Notes

MAR. 03, 2023

(NOTE: OPEN YOUR WEB BROWSER AND CLICK ON HEADING TO LINK TO SECTION)

CHEMICAL EFFECTS

[Adverse Human Health Effects of Chromium by Exposure Route: A Comprehensive Review Based on Toxicogenomic Approach](#)

[Impact of Pollutant Ozone on the Biophysical Properties of Tear Film Lipid Layer Model Membranes](#)

[Toxicity overview of endocrine disrupting chemicals interacting in vitro with the oestrogen receptor](#)

ENVIRONMENTAL RESEARCH

[The role of systemic inflammation and oxidative stress in the association of particulate air pollution metal content and early cardiovascular damage: A panel study in healthy college students](#)

PHARMACEUTICAL/TOXICOLOGY

[Implementation of effect biomarkers in human biomonitoring studies: A systematic approach synergizing toxicological and epidemiological knowledge](#)

[Perfluoroalkyl substance exposure is associated with asthma and innate immune cell count in US adolescents stratified by sex](#)

[Prenatal exposure to persistent and non-persistent chemical mixtures and associations with adverse birth outcomes in the Atlanta African American Maternal-Child Cohort](#)

OCCUPATIONAL

[Assessment of the Genotoxic and Cytotoxic Effects of Turpentine in Painters](#)

[Occupational Risk Factors by Sectors: An Observational Study of 20,000 Workers](#)

[Use of the Benchmark-dose \(BMD\) approach to derive Occupational Exposure Limits \(OELs\) for genotoxic carcinogens: N-nitrosamines](#)