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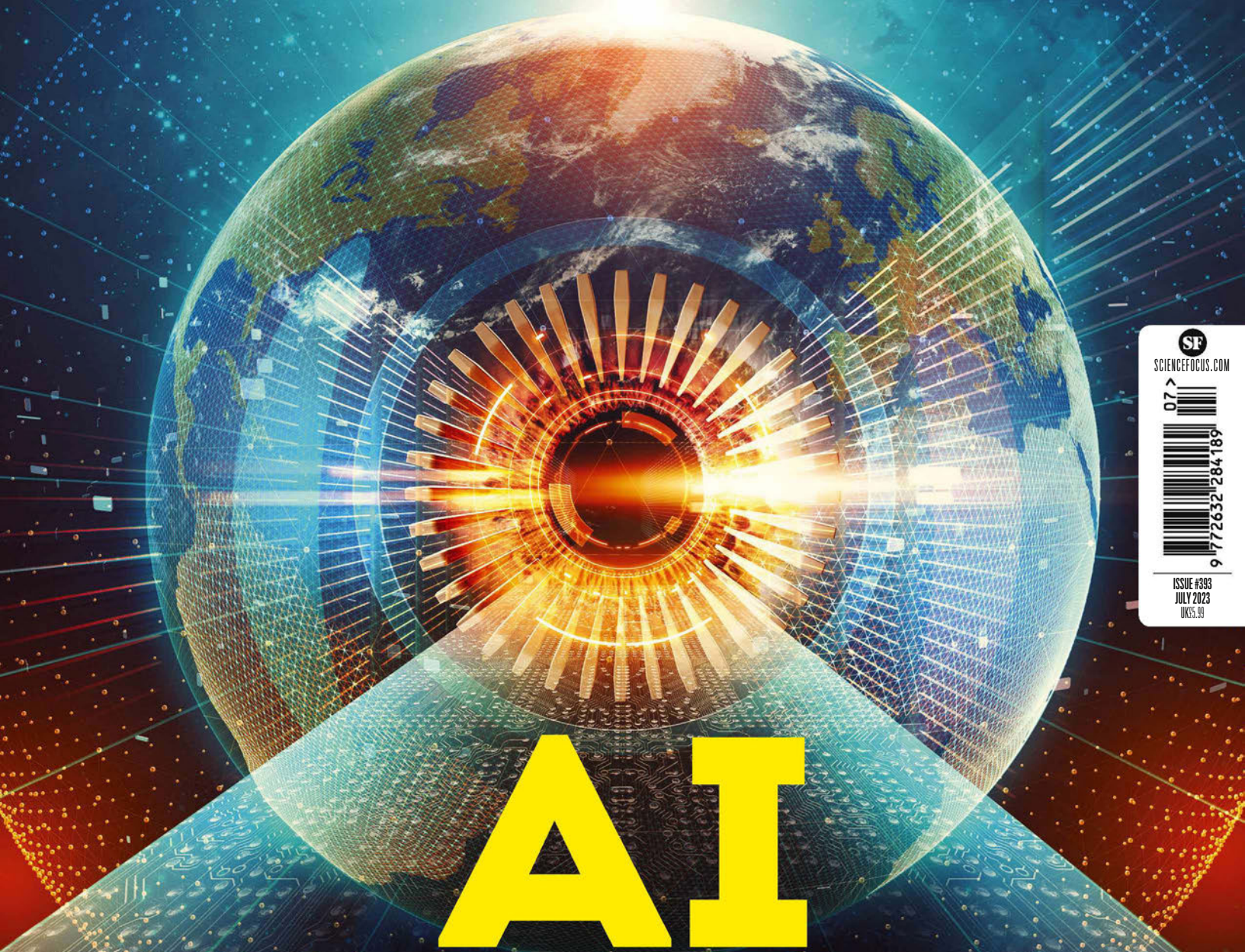

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# AI

WHAT OUR FUTURE WITH ARTIFICIAL INTELLIGENCE REALLY LOOKS LIKE, ACCORDING TO THE EXPERTS

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*How post-human intellects will save us*

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Inside the secret lives of bees

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KHADIJAH HORN, VIA EMAIL

# COULD AN ASTEROID IMPACT EVER CHANGE EARTH'S ORBIT?

Theoretically, any two objects colliding with each other will involve a transfer of momentum that alters their trajectories. So, even a micrometeorite, weighing less than a gram, could result in an imperceptible change in Earth's orbit around the Sun. However, things are not quite that simple.

Generally, the larger the impacting object the larger the effect of its impact. But the effect depends on many things, for example: the density and tensile strength of the impactor; the geology of the impact point; and the angle and velocity of the impact.

Crucially though, the transfer of momentum to Earth during an impact is far from total. This is because the impactor is often fractured or vaporised prior to hitting Earth's surface. The large kinetic energy of the impactor is converted mostly to heat (due to friction as it travels through Earth's atmosphere) and only a small amount is felt as mechanical energy. Even this small amount of mechanical energy goes mostly into deforming and fracturing Earth's surface and destroying the impactor. Almost none of the impactor's energy ends up changing Earth's momentum.

Scientists are aware of numerous large impact sites that survive on Earth's surface. The largest, Vredefort Crater in South Africa, implies an object about 20km in size, travelling at up to 90,000 km/h, hitting Earth about 2 billion years ago. That object was probably just 100-millionth of the mass of Earth. This huge mass difference, and the fact that very little momentum is transferred, implies that no known impact event has significantly altered Earth's orbit.

This doesn't mean that these impact events are without consequences. Most are associated with mass extinction events, such as the Chicxulub event, which accounts for the demise of the dinosaurs. Their immediate effect is to completely vaporise anything in their vicinity and perhaps create mega-tsunamis, earthquakes and volcanism. They're also thought to result in significant changes to Earth's atmosphere and the global climate. But what they don't do is throw Earth out of its orbit.

However, things were different in the Solar System's early history. Then, there were many more and much larger objects capable of impacting the infant planets. It's widely believed that the Moon is the result of a catastrophic impact with the primitive Earth. The orientation of Uranus's rotation axis (almost perpendicular to its orbital plane) suggests that an Earth-sized object crashed into it 3 to 4 billion years ago. These kinds of impacts, where the impactor's mass is a significant fraction of the planet's mass, would certainly have been powerful enough to alter their orbits. So, it's probably safe to say that all the planets of the Solar System have had their orbits altered by impacts. Exactly when, how and by what is, unfortunately, impossible to say. ***AG***

LUCINDA COX, SUSSEX

## WHY DO OLD BATTERIES LEAK?

Batteries generate electricity by chemical reactions that move electrons from one terminal to the other. Ordinary alkaline batteries use a potassium hydroxide gel as the conductive electrolyte, and the reactions in the gel generate a small amount of hydrogen gas. Since the battery is sealed, the pressure in the cell gradually builds and eventually causes tiny ruptures along the seams of the metal casing. The potassium hydroxide reacts with $CO_2$ in the air to form a harmless crust of potassium carbonate, but the potassium hydroxide itself is caustic and can cause skin irritation. Take your leaking batteries to the recycling centre in a plastic bag. ***LV***

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