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Solar physics

Hot topics

A new spacecraft will be the second in 18 months to examine the sun close up

THE SUN is one of the most-studied objects in the sky, but plenty of mysteries remain. On February 10th a rocket blasted off from Florida carrying *Solar Orbiter*, a European space probe designed to solve some of them. This craft will spend the next two years performing fly-bys of Venus and Earth, using the gravity of both planets to kick itself into an unusual orbit that will take it well above the ecliptic, the plane in which all of the sun's planets orbit.

From that vantage *Solar Orbiter* will peer at the sun's poles, something no spacecraft has managed before, and do so from close up. At its nearest, it will be just 42m km from the sun—closer than Mercury, the innermost planet, gets. One of its features is, therefore, a heat shield coated with charcoal made from cooked animal bone and designed to endure temperatures up to 500°C. Tiny windows within this will illuminate the probe's various instruments.

Those instruments are designed to shed light, as it were, on several questions. One concerns the solar wind, a flow of charged particles that streams from the sun at a rate of more than 1m tonnes a second. The solar wind blows at an average speed of 400km a second, but physicists do not know exactly what accelerates those particles to such a velocity. Another mystery is the sun's magnetic field. Every 11 years or so, for reasons only partly understood, this flips its north and south poles around. *Solar Orbiter*'s masters hope their charge will observe such a reversal, which is expected to happen within the next few years.

They also hope that *Solar Orbiter* will advance the nascent science of solar-weather forecasting. The entire solar system is bathed in the solar wind, which means that what happens on the sun can affect conditions around the planets. Solar flares—sudden spikes in the sun's brightness—boost radiation levels in the neighbourhood of Earth, which can interfere with satellites' electronics, alter their orbits and pose health risks to astronauts. Coronal mass ejections (CMEs), which are occasional burps of superheated plasma that the sun releases into space, can disrupt radio communications and induce large, potentially damaging electric currents in power grids, communication lines and the like.

These risks are not hypothetical. In 1859 a massive CME caused auroras as far south as the Caribbean and damaged telegraph systems all over America and Europe. Another, in 1989, caused nine-hour blackouts across large parts of north-eastern Canada. Britain's government lists a direct hit from a big CME on its National Risk Register of potential disasters, alongside floods, pandemic diseases and big terrorist attacks. Early warning of such space-going storms would help resist their effects.

Solar Orbiter is not the only craft soon to endure a close encounter with the sun. In 2018 NASA, America's space agency, launched the *Parker Solar Probe*. This will orbit even closer, at a distance of just 6.2m km. Researchers see the missions as complementary. *Parker* will fly through the corona, a tenuous atmosphere that stretches far out from the sun's luminous sphere, allowing it to sample the gas there directly. But that is much too close for any kind of direct optical observation, says Richard Harrison, chief scientist at the Rutherford Appleton Laboratory in Britain, and one of *Solar Orbiter*'s designers. *Parker*, in other words, suffers from the same limitation as Earthbound human astronomers: it cannot look directly at the blinding light emitted by the object it is studying. ■

Animal behaviour

Lake-bed properties

Fish, like people, must pay for their accommodation

TENANTS WHO don't pay the rent are a bane of landlords everywhere. And landlords who use heavy tactics to enforce payment are similarly a bane of tenants. Nor are these problems confined to human beings. Property-owning cichlid fish seem as ruthless about receiving what they are owed as any 19th-century tenement holder in the Lower East Side of New York.

The fish in question, *Neolamprologus pulcher*, inhabit Lake Tanganyika in east Africa. They are co-operative breeders, meaning that dominant individuals do the breeding and subordinates assist in various ways, in exchange for immediate survival-enhancing benefits that may lead to the ultimate prize of becoming dominant themselves. In the case of *N. pulcher* the main benefit is having somewhere to live. Dwellings, in the form of shelters dug out from sand under rocks, are controlled by dominant pairs. These dominants permit subordinates to share their accommodation, and those subordinates pay for the privilege by keeping the property in good repair and defending the dominants' eggs and fry against predators.

Though co-operative breeding by vertebrates has evolved several times (famous examples include the meerkat mongooses of southern Africa and the scrub jays of Florida), the question of how rental payments are enforced has never been definitively settled. The presumption is that dominants punish subordinate defaulters. But it is hard to prove, by observing wild animals, that this is what is happening.

What was needed to clear the point up was an experiment. And fish are easier to experiment on than mongooses or jays. Jan Naef and Michael Taborsky of the University of Bern, in Switzerland, therefore acquired 96 specimens of *N. pulcher* and created menages of a pair of dominant landlords and a subordinate tenant in sand-bottomed aquaria.

Left alone, the fish behaved much as they would have done in the wild, with the tenant doing the grunt work of maintaining the hollows in the sand, and good relations pertaining between all. However, if a tenant was prevented for a time from fulfilling its duties, by trapping it behind a partition inserted into the aquarium for that purpose, things changed. When the partition was removed, the landlords attacked it, and it showed a big increase in submissive behaviour for several minutes before things returned to normal.

Whether similar treatment would be meted out for a failure to defend the landlords' eggs has yet to be determined. When prevented by a partition from driving away predators, tenants were not subsequently on the receiving end of aggression from landlords—but since there were no eggs to defend at the time, that may not have been part of the contract. The predators in question, a species called *Telmatochromis vittatus*, are not a threat to adult specimens of *N. pulcher*, only to eggs and fry. It is nevertheless clear from Dr Naef's and Dr Taborsky's experiment that, for cichlids at least, the rent must be paid in a timely fashion, or punishment will be faced. ■

And I'm afraid I'll need a deposit up front