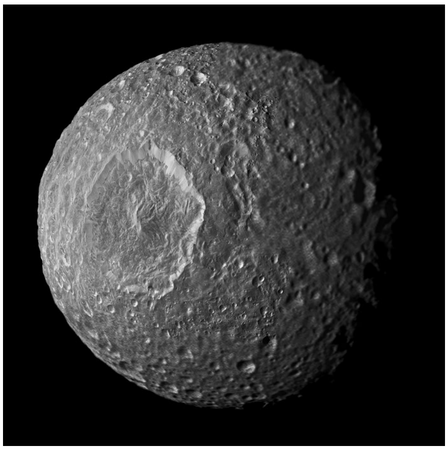
ASTROPHYSICS

Moonstone

Nat. Astron. https://doi.org/c4c3 (2019)



Credit: NASA/JPL-Caltech/Space Science Institute

Saturn's inner moons, Mimas, Enceladus, Tethys, Dione and Rhea, have different interior compositions of rock and ice. Surprisingly, these are not correlated with their mass or distance from Saturn itself. While an ocean is present on Enceladus, Mimas shows no sign of geological activity despite having a closer and more eccentric orbit that would be expected to give rise to much stronger tides. What is known about the moons' geology is not in line with their orbits.

Numerical simulations performed by Marc Neveu and Alyssa Rhoden may now provide an explanation. The simulations follow the evolution of the moons' orbits from their formation until today, over a time span of 4.5 billion years, and account for the development of their thermal, geophysical and orbital properties. Assuming that Mimas was formed less than 1 billion years ago from Saturn's rings, and the outer moons are much older, the different geologies are reconciled with the observed orbits. *SR*

https://doi.org/10.1038/s41567-019-0528-2

ORIGIN OF LIFE

An early template

Phys. Rev. X **9**, 011056 (2019)

The prebiotic soup from which we all started somehow gave rise to the complex sequences that now define our every feature. Shoichi Toyabe and Dieter Braun have found evidence in support of a self-selection mechanism that might have spontaneously broken the symmetry required to amplify some sequence motifs above the general noise level.

Toyabe and Braun studied the replication dynamics of templated ligation, where the binding of two complementary sequences is facilitated by a third template strand. They found that a vast sequence space could have been significantly reduced by replicating strands in this way, because the likelihood of binding would have increased as the sequences became longer, thus accelerating the process with self-promoted elongation.

Their experiments showed that in a restricted set, highly concentrated similar sequences fared better than their less concentrated or uncorrelated counterparts. Whether the same mechanism holds in a more diverse pool of random sequences remains to be seen. *AK*

https://doi.org/10.1038/s41567-019-0525-5

ANALOGUE COSMOLOGY

Universe in a bottle

Phys. Rev. E **99**, 031101(R) (2019)

Analogue simulations stir the inner physicist in all of us. It's almost miraculous that one physical system could be used to simulate and gain insights into another just by virtue of sharing fundamental equations. Yet the approach works — as we know for the case of black-hole analogue systems in fluids and superfluids. But these are not the only objects that can be explored in analogue gravity experiments.

Zack Fifer and colleagues now propose an analogy for the simulation of cosmological scenarios. Their idea is to consider the perturbations at the interface between two immiscible liquids. If the two liquids respond differently to time-varying magnetic fields, with a diamagnetic layer atop a paramagnetic one, the effective gravity felt by the system could be made time dependent. This provides a handle on the perturbation propagation speed — the analogue of the speed of light. Under the right experimental conditions, scale factors can be made to grow exponentially, just as in inflation scenarios, and initial small perturbations would get converted into large-scale structures as happened to our Universe. *FL*

https://doi.org/10.1038/s41567-019-0527-3

TOPOLOGICAL SUPERCONDUCTIVITY

Disordered Majoranas

Phys. Rev. Lett. **122**, 126801 (2019)

Majorana fermions can emerge from so-called *p*-wave topological superconductors. This superconducting state is known to be very fragile — it takes only a small amount of disorder to break it up. But, Arbel Haim and Ady Stern have suggested a material where disorder might actually help to make Majoranas more stable.

They model a Josephson junction where the weak link is made from a semiconductor with spin–orbit coupling. An analysis of the modes in the weak link shows that those most relevant for the superconductivity have the largest momentum, and hence the strongest spin–orbit coupling. This means that modes with opposite momentum have opposite spin, so 'backscattering' between them is suppressed. In turn, this means that the effective superconducting gap is enhanced for these channels, forcing any Majoranas that might emerge from them to be localized more strongly at the end of the Josephson junction, and hence be more robust. *DA*

https://doi.org/10.1038/s41567-019-0526-4

GRAPHITE

A heat wave

Science https://doi.org/gfw6bm (2019)

In non-metallic solids, heat is carried primarily by phonons, the quasiparticles that describe the lattice vibrations. Phonons scatter with each other, and the rate of this process determines how heat transfers across the system — ballistic or diffusive. Now, Samuel Huberman and co-workers have showed that, in an intermediate regime between these two limiting cases, heat can also be transferred like a wave, similar to the propagation of pressure waves in air, a phenomenon referred to as second sound.

The wave-like transfer of heat was observed in graphite. Two short laser pulses crossed at the surface of the sample created a heat source. The subsequent thermal expansion caused a transient modulation of the surface displacement, which can be monitored by a third laser beam. While at room temperature the modulation decayed monotonically, at lower temperature an oscillated damping was observed. The frequency of the wave-like dynamics exhibited a linear dependence on the wave vector, leading to the second-sound velocity extracted from the data. *YL*

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