Young and rich stars

Astron. Astrophys. **576,** L12 (2015)

Stars are chemical factories. Starting with hydrogen, stars produce all elements, light and heavy, within their cores and then blast them into space by supernovae. Depending on the amount of these various elements, it's possible to gauge the age of the progenitor star. Galactic archaeology depends on accurate measurements of the relative abundances of the light 'alpha' elements (mainly oxygen) and iron. In general, a high alpha to iron ratio, or [α/Fe], indicates an old star, as the lighter elements are released on a shorter timescale. But now Cristina Chiappini and co-workers have found a population of young stars with enhanced [α/Fe]. What does this mean?

First of all, Chiappini *et al.* used astroseismology for determining the ages of the stars. This involves the study of the pulsation frequencies of a star, in much the same way that seismologists can picture the core of the Earth without being able to look inside. In addition, the authors found that the stars lie near the inner Galactic disk, which suggests that the gas could be protected by the Galactic bar region — a kind of shelter from shocks in the spiral arms — and stay inert for longer. *MC*

Kept in the dark

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According to the standard model of cosmology, most of the matter in the known universe does not significantly absorb or emit electromagnetic radiation. The favoured explanation for the abundance of such dark matter is weakly interacting massive particles (WIMPs) that pervade the universe, but interact only through gravity and the weak force. Probing matter that interacts so weakly, however, presents significant challenges. The Super-Kamiokande neutrino observatory has now placed strict limits on the possible strength of interactions between protons and WIMPs.

Super-Kamiokande is a cylindrical detector in the Kamioka mine in Japan, which uses photomultiplier tubes to detect Cherenkov radiation emitted when neutrons interact with electrons or nuclei of water. But the flux of neutrinos from the Sun is expected to be dependent on WIMPs: interactions with the Sun's many nuclei should cause WIMPs to lose enough energy to become gravitationally bound and self-annihilate, increasing the neutrino flux. No significant neutrino excess was found after 3,903 days of Super-Kamiokande data, however, restricting the spin-dependent scattering cross-sections of protons and WIMPs with masses below 200 GeV c^{-2} — ruling out several WIMP candidates. *LF*

Collective response

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The graceful movements of animal collectives such as flocks of birds and schools of fish have long been studied by scientists interested in animal behaviour. Although the fundamental question of interest is ultimately about their evolutionary origin, significant strides in understanding their mechanistic origin in different species have been made by borrowing techniques from statistical mechanics. For example, it is now established that information such as a change of direction is effectively transmitted through the entire animal aggregate simply as a response mediated by nearest-neighbour interactions between individual animals — a process that is superficially similar to the many-body effects present in simple magnetic systems.

However, the seemingly instant reactivity of animal collectives to predatory attacks — such that they turn in unison to produce so-called escape waves — has so far eluded a simple description. Now, James Herbert-Read and colleagues have addressed this issue by studying the response of fish schools to simulated predatory attacks. They found that escape waves are initiated by individuals changing direction in response to a change in their neighbours' speed. This speed-based mechanism was confirmed numerically, and may explain how escape waves can propagate without centralized control. *AT*

DIY interactions

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Quantum simulators are cool because they provide a playground to study many-body physics. For example, you can build your own (simplified) analogue of a solid-state system by trapping ultracold atoms in an optical lattice. You can configure the lattice geometry and tune the short-range interactions between the atoms — providing all the ingredients necessary to emulate all sorts of models interesting to condensed-matter physicists. Still, one knob has been missing: controllable long-range interactions. Two studies have now shown how to produce and tune variable-range interactions between atoms, with the help of photonic crystals.

Inspired by the idea of optical cavity-mediated interactions, the two studies made use of photons confined in photonic structures. James Douglas and co-workers looked at one-dimensional photonic waveguides, whereas Alejandro González-Tudela and colleagues opted for a two-dimensional geometry. The beauty of these approaches is that the features of the photonic crystals' optical modes render the interactions both strong and controllable. And the ability to tune the interaction range from short to long holds exciting possibilities for the quantum simulation of many-body systems. *IG*

Sound cans

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Blowing across the top of an open, empty bottle or soda can produces a typical sound, formed when pressure waves are excited at a characteristic frequency. For an empty soda can, this so-called Helmholtz frequency is 420 Hz — just below that of a concert A.

Alexei Maznev and colleagues investigated an arrangement of 37 'hexagonally packed' empty soda cans, and showed that it could be used to focus sound. The authors drove six loudspeakers, arranged around this metamaterial in a symmetric way, at fixed frequencies in the range 360–430 Hz. They then measured the acoustic intensity profile just above the cans by means of a suspended movable microphone. Near the Helmholtz resonance frequency, the peak at the centre of the array narrowed down to 2 cm, around 1/40 of the sound wavelength.

Although this result suggests subwavelength focusing or resolution beyond the diffraction limit, the authors point out that this is not the case — such narrow intensity profiles cannot be obtained between 'lattice points'. But the study does make one think about the meaning of the diffraction limit in a periodic (meta)material. *BV*

Written by May Chiao, Luke Fleet, Iulia Georgescu, Andrea Taroni and Bart Verberck.