Mystery of the missing core

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Stars are blowing up all the time, but supernova SN 1987a is exceptional, as it was visible to the naked eye in the Southern Hemisphere. Neutrinos detected 2–3 hours before the light arrived on Earth suggest the formation of a compact object — usually a neutron star for progenitor stars in this mass range (roughly 20 solar masses). But despite continued monitoring and no shortage of speculation, nobody has been able to resolve any core. Now Giovanna Zanardo and co-authors provide tantalizing evidence for a pulsar — a rotating neutron star with a strong magnetic field.

The team used information from two southern telescopes, the Atacama Large Millimeter/submillimeter Array (ALMA) and the Australia Telescope Compact Array (ATCA), to separate the radiation from the inner core of the remnant from that due to the expanding shock wave. The eastern lobe shows shock waves of higher velocity, whereas an excess synchrotron emission consistent with a compact source producing shocked magnetized particle wind — as from a pulsar — lies to the west of the remnant. *MC*

Surfaces take charge

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Magnetization precession in a ferromagnet can be used to inject spin currents into a range of materials — an effect known as spin pumping. When spins are injected into a material with a large spin–orbit coupling, the inverse spin Hall effect, which causes spins with opposite signs to scatter in opposing directions, converts the spin current into a charge current. This combination of spin pumping and the inverse spin Hall effect is commonly used in spintronic devices. Yuki Shiomi and colleagues have now demonstrated a different type of spin-to-charge conversion using the surface states of a topological insulator.

The conductive topologically protected surface states of topological insulators exhibit a locking between the spin and momentum, so the spin direction determines the electron motion, and vice versa. Shiomi *et al.* used this spin-momentum locking to convert a pumping-induced spin current into a charge current. Although similar to the conversion reported in materials with a large Rashba coupling, much higher efficiencies should be possible with topological surface states, offering an alternative method for efficient spin-to-charge conversion. *LF*

Shall we dance

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Nucleons are fermions and, if not for their interaction, by the exclusion principle we would expect those in the majority — say, the neutrons — to have a higher average momentum. But short-range interactions lead to the exact opposite situation: when neutrons are abundant, high-momentum protons are more likely than high-momentum neutrons.

Using high-energy electron scattering, Or Hen and collaborators measured the momentum distributions of protons and neutrons in neutron-rich nuclei. They found that high-momentum neutron–proton pairs were much more common than proton–proton pairs. Invoking a ballroom analogy, the authors noted that if the ladies outnumber the gentlemen, the interactions involved in choosing dance partners will make for some unlucky ladies who do not get to dance. In neutron-rich atomic nuclei, high-momentum protons and neutrons will also pair up, leaving a larger number of low-momentum neutrons without a partner. This increases the average proton momentum leading to the situation in which the average momentum of a neutron is actually lower than that of a proton.

The authors note that further insight into this surprising conclusion may come from other interacting fermion systems, namely ultracold atomic gas experiments. *IG*

Through the looking glass

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Age may bring wisdom, but it also tends to come with the inability to see things clearly — even when they're right in front of you. Presbyopia is a common condition involving progressive difficulty focusing on nearby objects, and it's associated with a hardening of the lens of the eye. Scattering data reported by Giuseppe Foffi and colleagues may hold the key as to why this is the case: their measurements are consistent with the appearance of a glassy arrested state in solutions of α-crystallin — a protein known to be abundant in the lens.

The transparency of the lens, which is crucial for clear vision, has previously been linked to short-range order between α-crystallin proteins. Foffi *et al.* found that their protein solutions were structurally liquid-like, consistent with a polydisperse hard-sphere model. And their dynamic light scattering and viscometry measurements pointed toward the existence of a glass transition, corroborated by molecular dynamics simulations and mode-coupling theory. The results suggest that the α-crystallin in our lenses may have a role in the onset of presbyopia. *AK*

Edgy magnetism

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Graphene nanoribbons are narrow strips cut from a graphene sheet — ideal systems for exploring one-dimensional edge effects. Originally a playground for theoretical condensed-matter physicists, progress in nanotechnological fabrication techniques has now made producing ribbons with tailored atomic structures a reality.

The two basic graphene edge types are known as armchair and zigzag. The graphene carbon atom network consists of two sub-lattices; for a zigzag edge, the outermost atoms belong to only one sub-lattice, whereas an armchair edge contains atoms of the two sub-lattices. Gábor Magda and colleagues employed a nanolithography technique based on scanning tunnelling microscopy to make cuts along well-defined crystallographic orientations in graphene deposited on an Au(111) surface. Room-temperature tunnelling spectra confirmed armchair ribbons to be semiconducting with a bandgap that decreases with strip width. For ribbons with zigzag edges, an unexpected semiconductor-to-metal transition was observed at a critical width of about 7 nm. Calculations show that the transition is a finite-temperature effect and reveal magnetic ordering: at the critical width, the configuration of electron spins at opposite edges changes from antiferromagnetic to ferromagnetic. *BV*

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