EDUCATION

Friendly persistence

Phys. Rev. Phys. Educ. Res. (in the press); preprint at https://arxiv.org/abs/1708.01263

Attracting youngsters to STEM disciplines is a challenge. But once new students have started their courses, how can they be retained? A study of Justyna Zwolak and colleagues suggests that social integration outside the classroom is an important factor.

Zwolak et al. surveyed 273 students (from more than 20 different majors) enrolled in introductory physics courses at Florida International University. Every few weeks they asked them about their interactions with peers inside and outside the classroom and performed a complex social-network analysis of those data.

Unsurprisingly, for students with grades clearly above or below average, the best predictor of persistence was the final grade. However, whether students with grades in the 'middle of the pack' chose to commit to their studies depended more on how successfully they built up an out-of-class social network. This finding is in contrast to the role of in-class networks, which are not more correlated with persistence than grades, as these authors had found in earlier work. *AHT*

https://doi.org/10.1038/s41567-018-0173-1

SOFT MATTER

Metachronal magnets

Soft Matter https://doi.org/cpz9 (2018)

A fan-filled stadium is perhaps the most obvious place to find a metachronal movement — known to many as the Mexican wave (pictured) after it was popularized at the 1986 FIFA World Cup. Millipedes support them too, as do the cilia found on animal cells, which were the inspiration that led Srinivas Hanasoge and colleagues to come up with a biomimetic magnetic system capable of generating metachronal waves.

Credit: CoverSpot Photography/Alamy Stock Photo

Hanasoge et al. attached thin magnetic filaments to a substrate and submerged it in a viscous fluid, using a rotating magnetic field to deform the cilia to the point at which their elasticity prompted a recovery. By engineering a length differential between filaments, they were able to induce a phase difference in the movements of neighbouring cilia. The ensuing metachronal motion emerged solely from the filaments' magnetic and elastic properties, setting it apart from the hydrodynamically mediated waves observed in natural cilia. And as the latter can triple cellular propulsion speeds, there's hope for future devices based on their magnetic counterparts. *AK*

https://doi.org/10.1038/s41567-018-0174-0

PLASMON-INDUCED CHEMISTRY

Function at the junction

Science **360**, 521–526 (2018)

Concentrating light in the plasmonic near-field spectrum can be useful for molecular sensing and imaging — or for boosting light-induced chemical reactions. But given the complexity of the underlying physics, the mechanism behind a certain reaction is often unclear. To understand and perhaps even control such reactions, it is important to have a detailed look at the process — if possible, at the molecular level. Yousoo Kim and co-workers now have done exactly that, by resolving light-induced bond fission in a scanning tunnelling microscope.

Forming junctions between crystalline metal surfaces and nanotips, Kim and colleagues proved that the dissociation of a surface-bound molecule occurs directly via an intramolecular absorption process. Light impinging on the tip creates plasmonic near fields that excite electrons from binding to anti-binding orbitals, which are only weakly hybridized with the metal surface states. The set-up allowed Kim and colleagues to observe bond fission in real time and at high spatial resolution, which even enabled them to rule out alternative reaction mechanisms involving charge transfer. *JPK*

https://doi.org/10.1038/s41567-018-0177-x

DARK MATTER

Black hole limits

Phys. Rev. Lett. **120**, 191102 (2018)

Primordial black holes, formed during the first second of the life of the Universe, are one of many dark matter candidates. Now, Sai Wang and colleagues have used gravitational wave data from Advanced LIGO to tighten the upper limit on the abundance of primordial black holes by an order of magnitude.

If merger events between binary primordial black holes are common, then they should provide a stochastic background signal in the Advanced LIGO data. The first Advanced LIGO run didn't find evidence for such a signal, so the authors use this fact to constrain the energy density spectrum of primordial black holes as a function of their mass. For black holes between 1 and 100 solar masses, the total contribution to dark matter can be, at most, in the range of a few percent.

The enhanced sensitivity of future Advanced LIGO detection runs should give a measurable stochastic background signal and allow an even more stringent estimate of primordial black hole abundance. *DA*

https://doi.org/10.1038/s41567-018-0175-z

QUANTUM PHYSICS

Sound as a Bell

Nature **557**, 212–216 (2018)

The implications of John Stewart Bell's theorem are far from settled, and technological advances keep providing us with new ways of looking at it, often by resolving problems — or 'loopholes' — associated with the conclusions of existing experiments. A particular pesky one is the 'freedom-of-choice loophole'. Bell's tests require randomized measurements, but one could imagine (not without some creativity) that the random measurement choice and the system in question may be somehow subtly correlated, conspiring to fool us. This isn't totally crazy: so far the randomness has essentially always come from another quantum system.

But now, the members of the BIG Bell Test Collaboration have carried out a Bell test of unprecedented scale, setting this loophole aside for good. Their tactic was to use human free will as the random element of the test. Almost 100,000 participants across the world played a game that generated millions of random choices, which were used to select the measurement setting in 13 different experiments. Bell's inequality was simultaneously violated everywhere. *FL*

https://doi.org/10.1038/s41567-018-0176-y

David Abergel, Abigail Klopper, Jan Philip Kraack, Federico Levi and Andreas H. Trabesinger