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NOTE: Princeton Instruments x-ray cameras are compatible with EPICS software.

EPICS

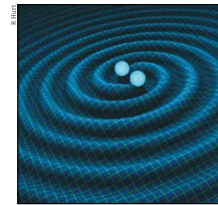


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NEWS DIGEST



Artist's impression of a gravitational-wave event.

New gravitational-wave events

The LIGO and VIRGO collaborations have detected four new gravitational-wave events, bringing the total number of observed events since the first detection in 2015 to 11. Ten of these events are from black-hole mergers, and one is from a neutron-star merger. Of the black-hole events, the new event GW170729 is the most massive and distant gravitational-wave source ever observed – it converted almost five solar masses into gravitational radiation and took place about 5 billion years ago. The teams describe their results in a catalogue that comprises confirmed and candidate events (arXiv:1811.12907) and an analysis of the properties of the black-hole mergers (arXiv:1811.12940).

Most precise electron moment

The ACME collaboration at Harvard University's Jefferson Physical Laboratory in the US has performed the most precise measurement of the electric dipole moment (EDM) of the electron (*Nature* **562** 355), providing a powerful test of the Standard Model (SM). The SM predicts a non-zero but very small EDM, whereas extensions of the SM such as supersymmetry posit larger and potentially measurable EDMs, in the range 10^{-27} – 10^{-30} . By measuring the electron spin precession in a superposition of quantum states of electrons subjected to a huge electric field, the ACME experiment (pictured) measured an upper limit for the electron's EDM of $1.1 \times 10^{-29} e \cdot \text{cm}$ – 8.6 times smaller than the best previous limit, also by ACME.

Open-science cloud launched
On 23 November, the European Commission launched the European Open Science Cloud (EOSC) – an open environment for researchers to store, analyse and re-use data for research, innovation and educational purposes. EOSC has emerged following extensive discussions with research infrastructures and scientists working across disciplines. For the astronomy and particle-physics fields, the ESCAPE project brings together the relevant research infrastructures, including CERN, to address their open-data science challenges and help build EOSC. Under the commission's Horizon 2020 programme, €600 million has been allocated to setting up EOSC by 2020.

New centre for particle physics

The German Research Foundation has established a new transregional centre to explore physics beyond the Standard Model with state-of-the-art theoretical methods and new search strategies. The centre, called Phenomenological Elementary Particle Physics after the Higgs Discovery, will be funded from January initially for four years with a total of around €12 million. It involves the Karlsruhe Institute of Technology (host institute), the University of Siegen and RWTH Aachen, in addition to researchers from the University of Heidelberg. The centre is one of 10 new collaborative research centres in Germany designed to enable researchers to pursue challenging, long-term research projects.

Physics resumes at RHIC

The 19th year of physics operations has commenced at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory in the US. This year the collider is being reconfigured for a lower-energy run to look for signs of a critical point in the nuclear phase diagram at which the transition from ordinary matter to a quark-gluon plasma switches from abrupt to continuous.

SNO+ searches for nucleon decay

Many grand unified theories predict the existence of nucleon decay as a mechanism to allow baryon-number violation and potentially explain the matter-antimatter asymmetry in the universe. A new search for invisible nucleon decays has been conducted during the initial water phase of the SNO+ detector in Canada, before the detector runs with a scintillator (arXiv:1812.05552). Invisible nucleon decays could be detected through gamma rays emitted by the de-excitation of an excited daughter of the oxygen nucleus. The new SNO+ search for such gamma rays has resulted in limits of 2.5×10^{29} yr for the partial lifetime of the neutron, and 3.6×10^{29} yr for the partial lifetime of the proton, the latter being a 70% improvement over the previous limit from SNO.

Glueballs revealed in the pion

Glueballs contribute more to the total momentum of the pion – which is the lightest hadron – than previously thought. That's the conclusion of Patrick Barry of North Carolina State University and co-workers, who have published the first global QCD analysis of the parton distribution functions of the pion (*Phys. Rev. Lett.* **121** 152001). By using a Monte Carlo approach based on nested sampling, the analysis combined data from fixed-target and collider experiments to show that glueballs contribute 30% of the total pion momentum – which is three times more than the previous estimate.

Belle II vertex detector installed

The final piece has been inserted into the Belle II detector (pictured) at the SuperKEKB accelerator in Japan. When fully commissioned, Belle II – the "super-B factory" upgrade of the Belle detector – will detect events at the much higher rates provided by the 40-fold higher design luminosity of SuperKEKB compared to KEKB. This final component, the vertex detector, has two parts that now complete the overall detector: a two-layer pixel detector based on "DEPFET" technology, and a four-layer double-sided silicon-strip detector. The first layer lies just 14 mm from the interaction point to improve Belle II's vertex resolution significantly.



The vertex detector being incorporated into Belle II.

Metamaterial for acceleration

A team led by Richard Temkin at the Massachusetts Institute of Technology in the US has shown that an artificially engineered "metamaterial" could be an alternative to materials currently used in the emerging technology of wakefield acceleration. This type of acceleration relies on the intense electromagnetic field produced in the wake of an electron bunch that travels through a plasma or dielectric material to accelerate particles, and can reach higher accelerating gradients than conventional techniques. However, it has disadvantages such as limited tunability of the plasma (or dielectric) and a lower beam quality. Temkin and co-workers have engineered a metamaterial, made of steel and copper plates, that has both a high gradient and a high degree of tunability (*Phys. Rev. Lett.* **122** 014801).



The ACME experimental set-up.

