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Physics news on the Internet (based on electronic preprints)

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1. Chemical element 118

Nuclei of the still-to-be-named chemical element with atomic number $Z = 118$ and mass number $A = 294$ have been discovered by a Russian team at the Joint Institute for Nuclear Research in Dubna in collaboration with colleagues from the Lawrence Livermore National Laboratory in the US. The nuclei of element 118 were created in collisions of a beam of ^{48}Ca ions with a target of ^{249}Cf atoms. In the course of the experiment, three such nuclei were unambiguously identified by their characteristic decay chains into lower-mass daughter nuclei. As a preliminary work, a series of experiments have been performed in the last few years looking at the synthesis and the decay properties of chemical elements 112, 114, and 116. In particular, $^{245}\mathrm{Cm} + {}^{48}\mathrm{Ca}$ collisions producing element 116 nuclei were studied in detail, providing improved decay schemes for superheavy nuclei and yielding the optimized technique for producing element 118. In the Dubna experiment, which used about 4×10^{19} ^{48}Ca ions cyclotron-accelerated to 251 MeV, the nuclei of element 118 were produced in the $^{249}\mathrm{Cf} + {}^{48}\mathrm{Ca}$ fusion reaction with a cross section of $0.5^{+1.6}_{-0.3} \times 10^{-36}$ cm^2 and had a decay period of $0.89^{+1.07}_{-0.31}$ms. Creating superheavy elements is of interest in particular for testing the existence of the so-called 'stability island', a theoretically predicted group of superheavy nuclei with nearly filled nucleon shells.

Sources: *Phys. Rev.* **C 74** 044602 (2006);
www.prc.aps.org

2. Bose – Einstein condensation of magnons and polaritons

A team of researchers from Germany, Ukraine, and the US has for the first time observed the Bose – Einstein condensation of magnons (spin wave quanta or quasiparticles) in an yttrium – iron – garnet film at room temperature. The magnons were excited by short microwave pulses in a thin YIG film placed in a magnetic field. The magnon concentration achieved in the experiment was high enough for the magnons even to Bose-condense at room temperature. The spectrum of the magnons was measured from the way they scattered laser light photons. Soon after the microwave pulse terminated, all the magnons disappeared — except for one narrow spectral peak which corresponded to the Bose – Einstein condensate and which remained stable for quite a long time (above 10 μs).

The term polariton refers to the quasiparticle comprising an electron – hole pair (exciton) with the photon it binds. Although polaritons may have been Bose-condensed in semiconductors according to reports, the previous experiments were not definitive as they did not measure polarization and spatial coherence. Now a new experiment by J Kasprzak and his colleagues from France, Switzerland, and the UK have remedied this omission. The researchers excited polaritons in a CdTe-crystal-based microcavity using laser light and used an interferometer to study the emission spectrum of the polaritons. The result was a macroscopic polarization and spatial coherence picture characteristic of a Bose – Einstein condensate. The findings of the experiment can be utilized to develop a 'polariton laser' and realize Bose condensation at elevated temperatures with wider bandgap semiconductors such as ZnO or GaN, according to the team.

Sources: *Nature* **443** 409 (2006); *Nature* **443** 430 (2006)
www.nature.com

3. Melting-point hysteresis of nanocrystals

Unlike macroscopic samples, the melting mechanism of nano-sized crystals is to a large extent determined by surface effects. In particular, embedding nanocrystals in the bulk of a different crystalline material increases their melting point because the crystal lattice surrounding them acts to suppress atomic vibrations near the nanocrystal's surface. The previous belief was that this effect does not occur if the surrounding medium is amorphous (for example, glass) rather than crystalline. Now researchers from Lawrence Berkeley National Laboratory and the University of California in the US together with their colleagues from Australian National University in Canberra have studied the way in which Ge nanocrystals embedded in the bulk of silicate glass (SiO_2) melt and solidify. The phase state and melting temperature of the nanocrystals were determined from whether the electron diffraction technique does or does not produce a diffraction pattern (thus implying a crystal and a melted particle, respectively). It was found that the melting process is strongly hysteretic. While melting occurs at a temperature 199 K higher than for the free macroscopic Ge samples, the subsequent solidification of the melted nanocrystals required cooling to 256 K below the free Ge melting point. This result, although surprising at first, was explained by a melting model which accurately includes all the material parameters, as well as those describing melting process dynamics and the geometries of the nanocrystal and glass surfaces that interact with each other.

Sources: *Phys. Rev. Lett.* **97** 155701 (2006);
www.prl.aps.org

4. Formation of massive stars

In the current view, stars start forming as a result of high-density gas clouds being compressed by gravity, and once the central core of a star has formed, the star's mass continues to grow due to the surrounding matter accreting onto it. However, the detailed nature of this process still remains in many respects obscure — especially for stars much more massive than the Sun. The radiation emitted by a young star exerts an outward pressure which hampers the matter

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accretion/mass growth process for stars about eight times the mass of the Sun. As a way out, a number of models have been suggested, including a merger of several stars and non-spherical accretion. Now observations of G24.78 + 0.08, a star about 20 times as massive as the Sun, made with the VLA interferometer of the NRAO have added weight to the latter model. Specifically, VLA astronomers measured the Doppler shifts of spectral lines from ammonia molecules to determine the speed of gas flows near the star. For the first time, three types of motion were found to simultaneously exist: a toroidal gas cloud orbiting the star, the inward (starward) motion of matter, and gas outflow from the star along the axis of rotation — all this indicating that disk accretion is at work here, a scenario which does not seriously prevent gas from falling onto the star and increasing its mass.

Sources: *Nature* **443** 427 (2006); www.nature.com
http://arxiv.org/abs/astro-ph/0609789

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