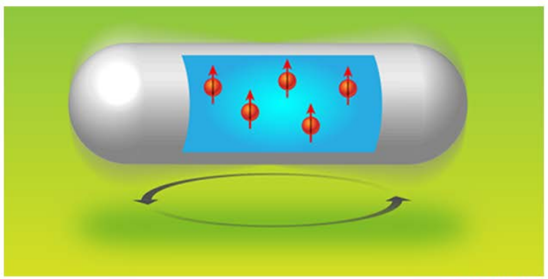
PHYSICAL REVIEW LETTERS **122**, 177202 (2019)

Editors' Suggestion | Featured in Physics

Observation of the Nuclear Barnett Effect

Mohsen Arabgol[*] and Tycho Sleator[†]
Department of Physics, New York University, 726 Broadway, New York, New York 10003, USA

Researchers demonstrate that they can magnetize hydrogen nuclei in water by rotating the liquid at high speeds.



APS/Alan Stonebraker

Rotate a metal rod fast enough and the rod will spontaneously magnetize, with the spins of its electrons all aligning so that they point in the same direction. Tycho Sleator of New York University (NYU) and his colleagues wondered if a similar method could polarize electrons in brain tissue samples to help improve imaging. This question led to studies that looked at rotation-induced polarization of electrons in this largely water-based material. The imaging project ultimately died, but Sleator and his NYU colleague Mohsen Arabgol continued the line of research, studying whether the spins of nuclei—and not just electrons—might align if water was rotated at high speeds. They have now demonstrated this effect.

In their experiments, the team filled a 2 mm by 8 mm hollow section of a rod with water and set the rod twirling. They then used a nuclear magnetic resonance (NMR) technique to measure the rotation-induced magnetization of the water. For a rotation rate of just over 4000 revolutions per second (rev/s), Sleator and Arabgol observed a 1% increase in the water's magnetization over the small magnetization effect induced by the NMR technique. This excess magnetization rose to just over 3% at 13,500 rev/s.

This demonstration comes over 100 years after Samuel Barnett discovered the electronic counterpart of this effect—known as the Barnett effect—in 1915. The team says that their realization of the "nuclear" Barnett effect was only possible because of recent technological advances that allow for very-high-speed rotation of materials.

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NEWS · 08 MAY 2019

nature
International journal of science

China's mountain observatory begins hunt for origins of cosmic rays

The Large High Altitude Air Shower Observatory is now operational.

China's search for the origins of high-energy cosmic rays — particles that shower Earth from outside the Solar System — has kicked off. A ceremony to launch the first phase of the Large High Altitude Air Shower Observatory (LHAASO) was held on 26 April, three weeks after the facility started making observations.

Cosmic rays are composed of subatomic particles, such as protons or atomic nuclei, which can reach almost the speed of light when travelling through space. A number of phenomena, such as supernovae, are thought to produce them, but the origin of the most energetic of these particles, known as ultra-high-energy cosmic rays, is still a mystery.

That's in part because cosmic rays, which carry a charge and so are bounced around by magnetic fields on their way to Earth, are difficult to trace.

The search for ultra-high-energy γ-rays is underway high on the Tibetan Plateau, at the Large High Altitude Air Shower Observatory. Credit: Xinhua/Alamy

A different track

The LHAASO will take an indirect approach. Set more than 4.4 kilometres above sea level in Daocheng, Sichuan, on the eastern part of the Tibetan Plateau, it will track another form of radiation — high-energy γ-rays. Researchers suspect that these come from the same astrophysical phenomena as cosmic rays, but because γ-rays don't carry a charge they travel in straighter lines and are easier to trace. Following the path of γ-rays could therefore lead scientists to a cosmic-ray producer.

Sources of high-energy γ-rays have been identified, including flaring supermassive black holes called blazars. None of these has also been confirmed to produce cosmic rays, although there are hints that they do.

Altitude advantage

The LHAASO's four detector arrays will be the first to measure ultra-high-energy γ-rays — those in the peta-electronvolt (10^{15} eV) range. Earth's upper atmosphere absorbs these rays, which splinter into showers of lower-energy particles. The observatory's high altitude means its detectors will be able to capture these particles before they decay to much lower energies.

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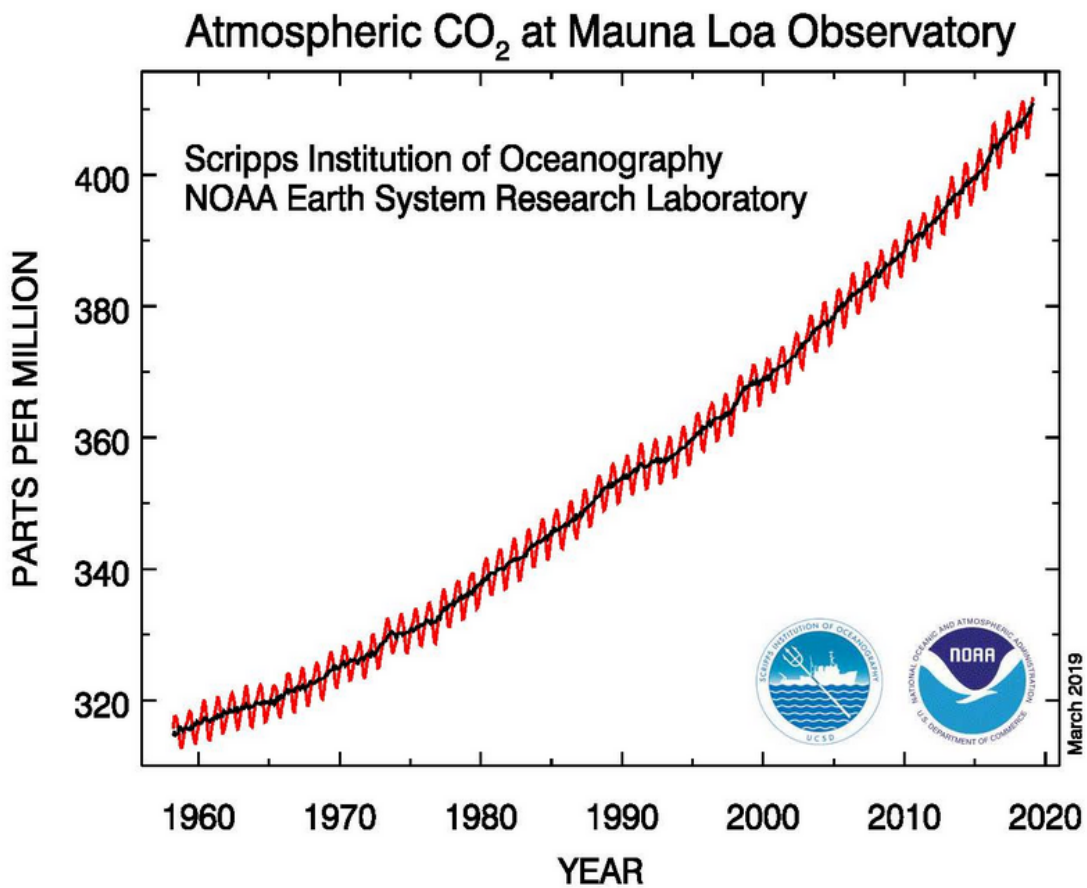
Global carbon dioxide growth in 2018 reached 4th highest on record

Climate Research | carbon dioxide greenhouse gases SHARE

March 22, 2019 — By the end of 2018, NOAA's atmospheric observatory at Mauna Loa recorded the fourth-highest annual growth in the concentration of atmospheric carbon dioxide (CO_2) in 60 years of record-keeping.



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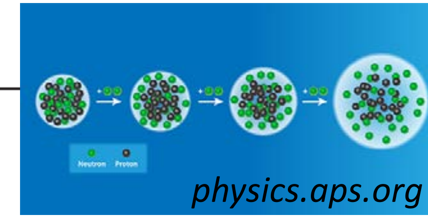
PHYSICAL REVIEW LETTERS **122,** 192502 (2019)

Editors' Suggestion **Featured in Physics**



Laser Spectroscopy of Neutron-Rich Tin Isotopes: A Discontinuity in Charge Radii across the $N = 82$ Shell Closure

C. Gorges,[1,*] L. V. Rodríguez,[2,†] D. L. Balabanski,[3] M. L. Bissell,[4] K. Blaum,[5] B. Cheal,[6] R. F. Garcia Ruiz,[7,8,4] G. Georgiev,[2] W. Gins,[7,‡] H. Heylen,[5,8] A. Kanellakopoulos,[7] S. Kaufmann,[1] M. Kowalska,[8,§] V. Lagaki,[8,9] S. Lechner,[8,10] B. Maaß,[1] S. Malbrunot-Ettenauer,[8] W. Nazarewicz,[11] R. Neugart,[12,5] G. Neyens,[7] W. Nörtershäuser,[1,∥] P.-G. Reinhard,[13] S. Sailer,[14] R. Sánchez,[15] S. Schmidt,[1] L. Wehner,[12] C. Wraith,[6] L. Xie,[4] Z. Y. Xu,[7] X. F. Yang,[7,16] and D. T. Yordanov[2,¶]

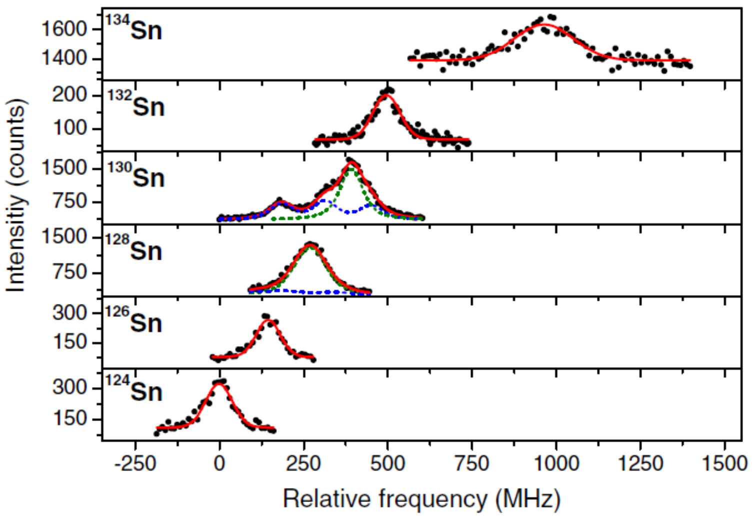
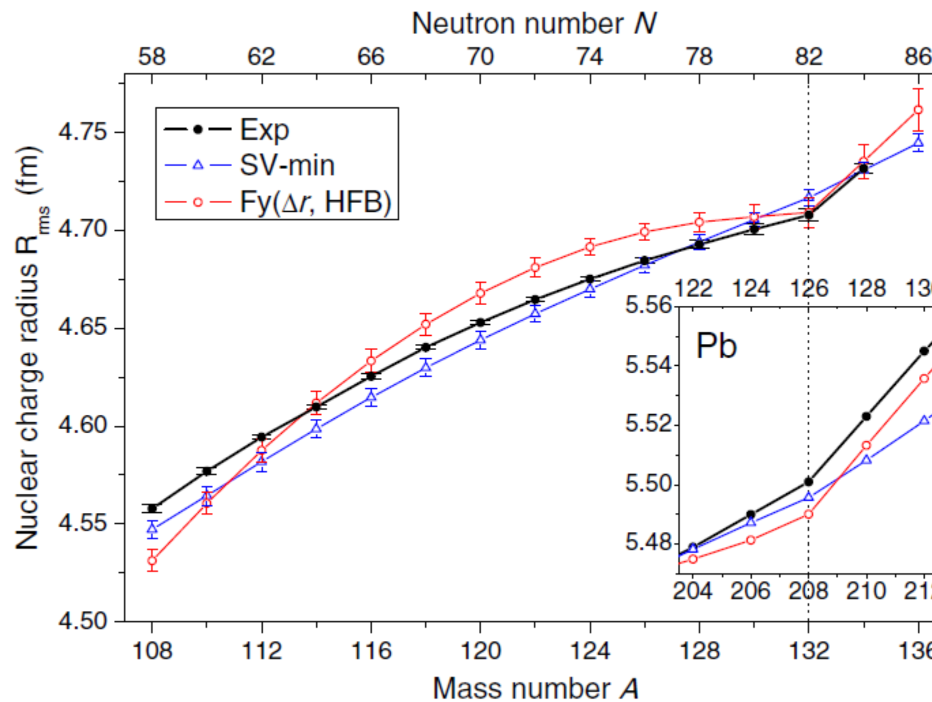


FIG. 1. Optical spectra of even neutron-rich Sn isotopes for the determination of the isotope shift in the $5p^2\,{}^1S_0 \rightarrow 5p6s\,{}^1P_1$ (SP) transition. The number of photomultiplier events is plotted as a function of the Doppler-tuned frequency relative to the resonance center of ^{124}Sn. The red line represents the fitted Voigt profile. For ^{128,130}Sn, the contribution of an isomer (dashed, blue line) and the $I = 0$ ground state (dotted, olive line) are plotted individually, with a significantly smaller isomer-to-ground-state ratio in ^{128}Sn.



Editors' Suggestion

New Isotope ^{220}Np: Probing the Robustness of the $N = 126$ Shell Closure in Neptunium

Z. Y. Zhang (张志远),[1,2] Z. G. Gan (甘再国),[1,2,*] H. B. Yang (杨华彬),[1] L. Ma (马龙),[1] M. H. Huang (黄明辉),[1,2] C. L. Yang (杨春莉),[1,2] M. M. Zhang (张明明),[1,2] Y. L. Tian (田玉林),[1,2] Y. S. Wang (王永生),[1,2,3] M. D. Sun (孙明道),[1,2,3,†] H. Y. Lu (卢洪洋),[1,2] W. Q. Zhang (张文强),[1,2] H. B. Zhou (周厚兵),[4] X. Wang (王翔),[5] C. G. Wu (武晨光),[5] L. M. Duan (段利敏),[1,2] W. X. Huang (黄文学),[1,2] Z. Liu (刘忠),[1,2] Z. Z. Ren (任中洲),[6] S. G. Zhou (周善贵),[7,8] X. H. Zhou (周小红),[1,2] H. S. Xu (徐瑚珊),[1,2] Yu. S. Tsyganov,[9] A. A. Voinov,[9] and A. N. Polyakov[9]

A new short-lived neutron-deficient isotope ^{220}Np was synthesized in the fusion-evaporation reaction ^{185}Re(^{40}Ar, $5n$)^{220}Np at the gas-filled recoil separator SHANS. Based on the measurement of the correlated α-decay chains, the decay properties of ^{220}Np with $E_\alpha = 10040(18)$ keV and $T_{1/2} = 25^{+14}_{-7}$ μs were determined, which are in good agreement with theoretical predictions. From the new experimental results coupled with the recently reported α-decay data of ^{219,223}Np, the α-decay systematics for Np isotopes around $N = 126$ was established, which allows us for the first time to test the robustness of the $N = 126$ shell closure in $Z = 93$ Np isotopes. The results also indicate that, in the region of nuclei with $Z \geq 83$, the proton drip line has been reached for all odd-Z isotopes up to Np.

In conclusion, we have reported the discovery of the $N = 127$ isotope ^{220}Np, which was produced in the fusion-evaporation reaction ^{40}Ar + ^{185}Re. With the digital electronics and the position-time correlation measurement, the α-particle energy and half-life of ^{220}Np were determined to be 10 040(18) keV and 25^{+14}_{-7} μs, respectively. Good agreement of the measured ground-state decay properties with the theoretical predictions was obtained.