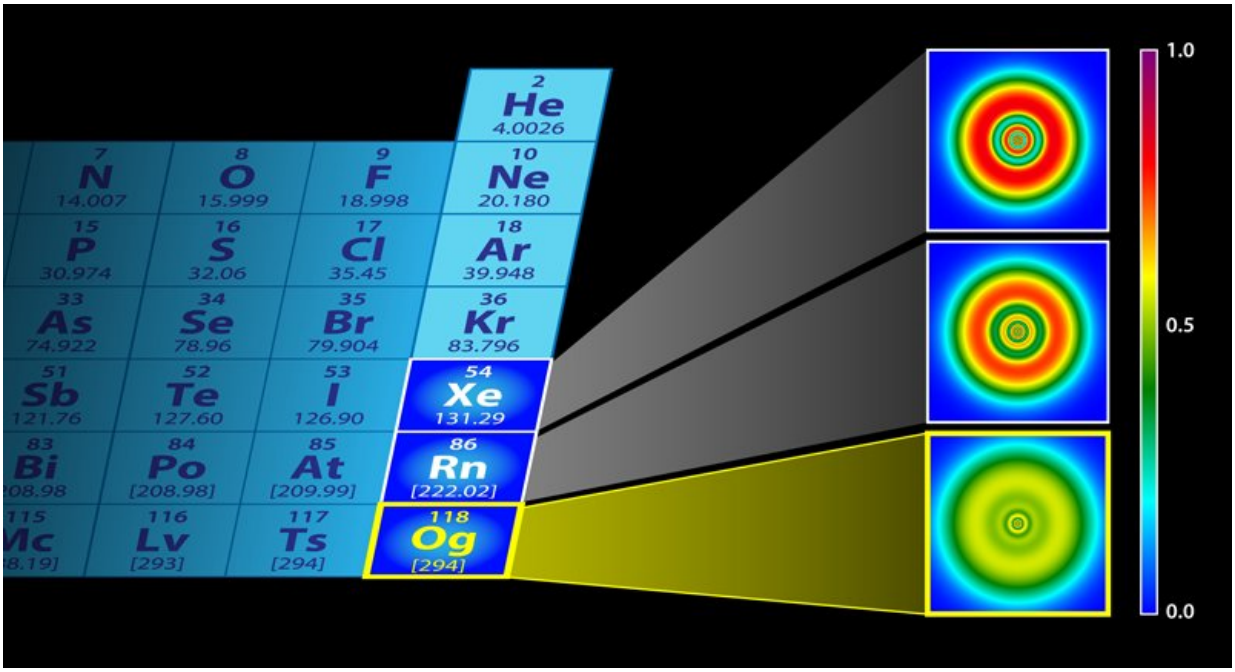
Group uses computer simulations to theorize characteristics of heaviest element oganesson

February 16 2018, by Bob Yirka



Credit: P. Jerabek et al. [4] and APS/Alan Stonebraker

A team of researchers from the U.S., New Zealand and Norway has used computer simulations to predict several characteristics of the heaviest element, oganesson. In their paper published in the journal *Physical Review Letters*, the group explains the factors that went into the simulation and discuss what it showed.

Back in 2002, a group of researchers from the U.S. and Russia succeeded in creating an atom of oganesson, the heaviest element on the periodic table. Named after Russian physicist Yuri Oganessian, the element has been notoriously difficult to study due to its short half-life (less than a millisecond). For that reason, most of its fundamental characteristics were determined using atomic calculations. In this new effort, the researchers have applied several physics techniques to derive predictions regarding other characteristics of the superheavy noble gas.

To give the simulation a means for calculating characteristics of the element, the group used fermion localization. That allowed them to create maps showing localizations for both electronic systems and nuclear systems. The researchers say it is likely that the element has uniform distribution of both electrons and nucleons, which was a surprise, because it contrasts sharply with nonuniform shells seen in lighter elements. These findings suggest that oganesson likely has characteristics or properties that differ from the other noble gases. The researchers also noted a surprisingly high value for spin-orbit coupling.

To learn more about the electronic structure of the element, the group made some assumptions regarding electrostatic forces causing electron energy levels to overlap, resulting in smooth electron shells. To back up their assumptions, the team added an electron localization function to the simulation, which allowed them to compare the electronic structure of oganesson with other noble gases. This revealed that the shell features were nearly the same, a finding that suggests the element would have strong Van der Waals forces between same-type atoms. The simulation also revealed more about properties inside the nucleus that would also contribute to a smooth shell structure.

The work is likely to inspire other new efforts geared toward measuring or observing the characteristics suggested by the simulation. It could also spur efforts to learn more about the element's strange properties.

More information: Paul Jerabek et al. Electron and Nucleon Localization Functions of Oganesson: Approaching the Thomas-Fermi Limit, *Physical Review Letters* (2018). DOI: 10.1103/PhysRevLett.120.053001

ABSTRACT

Fermion localization functions are used to discuss electronic and nucleonic shell structure effects in the superheavy element oganesson, the heaviest element discovered to date. Spin-orbit splitting in the 7p electronic shell becomes so large (~10eV) that Og is expected to show uniform-gas-like behavior in the valence region with a rather large dipole polarizability compared to the lighter rare gas elements. The nucleon localization in Og is also predicted to undergo a transition to the Thomas-Fermi gas behavior in the valence region. This effect, particularly strong for neutrons, is due to the high density of single-particle orbitals.

© 2018 Phys.org

Citation: Group uses computer simulations to theorize characteristics of heaviest element oganesson (2018, February 16) retrieved 19 April 2024 from https://phys.org/news/2018-02-group-simulations-theorize-characteristics-heaviest.html

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.