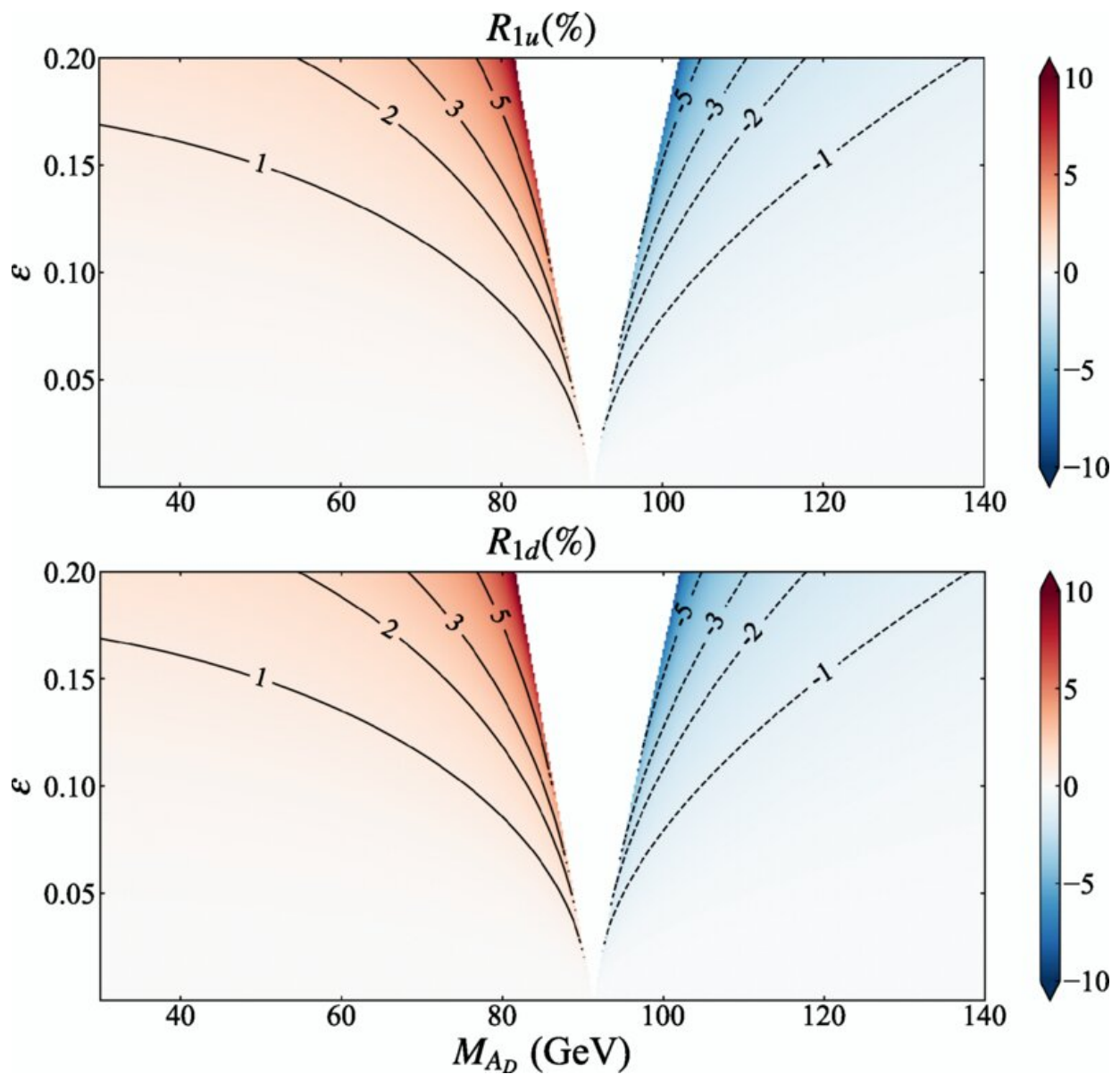


Shining a light on dark matter one particle at a time

July 8 2022, by Crispin Savage



The correction factors R_{1u} and R_{1d} at $Q^2=0.00616 \text{ GeV}^2$, appropriate to the PREX-II experiment. The gap on the ϵ - M plane is not accessible because of "eigenmass repulsion" associated with the Z mass. Credit: *Physical Review Letters* (2022). DOI: 10.1103/PhysRevLett.129.011807

University of Adelaide experts are trying to unlock the secrets of dark matter, which makes up 84% of the matter in the universe, but we know little about it. Researchers are using a new tool that could signal the existence of a new particle.

"We are trying to solve the problem of understanding one of the grand challenges facing [modern science](#)—how to find what type of particle [dark matter](#) is composed of," said Professor Anthony Thomas, Elder Professor of Physics, University of Adelaide.

"Dark [matter](#) is five times more plentiful than the visible matter that physicists have explored so successfully and of which we are composed.

"We do not know what kind of particle makes up dark matter but we, along with a very large number of people around the world, want to understand this."

Professor Thomas is one of the team at the ARC Center of Excellence for Dark Matter Particle Physics which aims to discover more about this mysterious substance.

One key approach is the Sodium Iodide with Active Background Rejection Experiment (SABRE) that is being built in a new laboratory in a former gold mine one kilometer underground in Stawell, Victoria. It is being constructed in collaboration with researchers in Australia, Europe, and the United States, and in a few years' time it will hopefully shed light

on this question.

Professor Thomas's latest work with colleagues Dr. Xuangong Wang and Professor Anthony Williams from the University Adelaide's School of Physical Sciences, published in the journal *Physical Review Letters*, explores the possibility that dark matter exists in the form of a dark massive photon.

"We are exploring the discovery potential of a new tool, parity violating electron scattering, which has been enabled by the upgrade at Thomas Jefferson National Accelerator Facility (JLab) in the United States," said Professor Thomas.

"Parity violation is like looking at the difference between what happens in the laboratory and what happens when you view the experiment in a mirror. The differences are very small, typically less than a part per million, but incredibly [precise measurements](#) enable us to observe this and use it as a signal of the existence of this new particle.

"We found a mysterious result for the size of a lead nucleus which may be explained if there is a particular new dark matter particle, the dark photon.

"New experiments where changes in the predictions without any dark matter could be modified by as much as five percent, with the difference providing direct evidence for this type of dark matter."

Knowledge about this new particle from Professor Thomas's work may help explain a surprising discrepancy that has been inferred from experiments at JLab between the neutron density in a lead nucleus and that predicted by nuclear structure theory.

"A vital test of the existence of such a particle could be provided by

future experiments into the behavior of electrons, positrons and deuterons," he said.

"Visible matter is just the tip of the iceberg. With a better understanding of dark matter, the part of the iceberg below the surface, we will shine a light on the secrets of our universe."

More information: A. W. Thomas et al, Sensitivity of Parity-Violating Electron Scattering to a Dark Photon, *Physical Review Letters* (2022). [DOI: 10.1103/PhysRevLett.129.011807](https://doi.org/10.1103/PhysRevLett.129.011807)

Provided by University of Adelaide

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