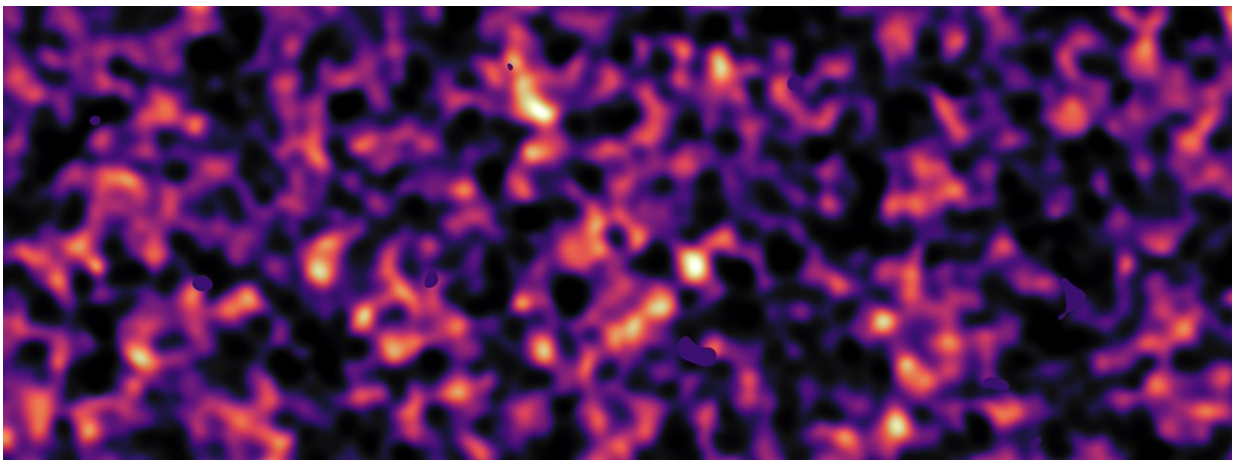
Study suggests two novel methods of searching for dark matter by measuring tiny perturbations in fundamental constants

April 9 2020



Dark matter map of KiDS survey region (region G12). Credit: KiDS survey

Dark matter, which cannot be physically observed with ordinary instruments, is thought to account for well over half the matter in the Universe, but its properties are still mysterious. One commonly held theory states that it exists as 'clumps' of extremely light particles. When the earth passes through such a clump, the fundamental properties of matter are altered in ways that can be detected if instruments are sensitive enough. Physicists Rees McNally and Tanya Zelevinsky from Columbia University, New York, USA, have now published a paper in *EPJ D* proposing two new methods of looking for such perturbations

and, thus, dark matter. This paper is part of a special issue of the journal on quantum technologies for gravitational physics.

Until now, searches for dark matter clumps have relied on the fact that tiny changes in the values of fundamental constants will alter the 'tick rate' of atomic clocks, some of which may be precise enough to pick up this difference. McNally and Zelevinsky's work adds methods that involve measuring a small extra 'push' or acceleration on normal matter caused by the clump, using, firstly, gravity sensors and, secondly, gravitational wave detectors. Gravity sensors are already spread around the world in the IGETS network, which is used for geological research; and scientists at the LIGO observatories in the United States are already looking for gravitational waves. Thus, McNally and Zelevinsky can mine the data from these ongoing experiments for evidence of dark matter.

McNally explains that this work was inspired by two things: the benefits of re-purposing existing experiments, and science fiction. "I enjoy novels like *A Fire Upon the Deep* [by Vernor Vinge] and *The Three-Body Problem* [by Liu Cixin] that explore what might happen if fundamental constants change, and it's fun to explore such things in the real world." As for practical applications of this work, however, he advised taking things one step at a time. "First we need to find out what dark matter is, then maybe we can find out how to use it."

More information: Rees L. McNally et al, Constraining domain wall dark matter with a network of superconducting gravimeters and LIGO, *The European Physical Journal D* (2020). DOI: 10.1140/epjd/e2020-100632-0

Provided by Springer