Dark matter may be undetectable

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Super-WIMPs might hide ninety percent of the universe.

Researchers look for WIMPS down Boulby Mine in Yorkshire. © SPL

Researchers going underground to detect signs of the elusive dark matter thought to far outweigh normal matter in the Universe might be wasting their time, a team of physicists is suggesting.

Jonathan Feng and colleagues at the University of California at Irvine propose that dark matter, which is believed to constitute around 90% of all the matter in the Universe, is hiding in the form of particles called super-WIMPs that would evade all conventional dark-matter searches[1].

Currently, one of the leading suspects for the inexplicable gravitational pull that stars and galaxies experience are WIMPs —weakly interacting massive particles. These are heavy relative to the protons and neutrons that make up atoms, and so have strong gravitational effects. Otherwise they hardly influence normal matter at all.

In the hope of detecting very rare collisions between WIMPs and normal particles, physicists in Europe and the USA have set up detectors far beneath the Earth's surface, shielded from cosmic rays.

Such efforts might prove fruitless, warns Feng's team. Their proposed super-WIMPs interact so weakly as to be effectively invisible. "Super-WIMPs are impossible to discover directly and escape all indirect detection experiments," they conclude.

But the researchers offer dark matter hunters new quarry. They think that the formation of super-WIMPs in the very early days of the Universe might have left detectable imprints in the cosmos. One signature would be an anomalously large number, at a certain energy, of the gamma rays that pervade all of space. This 'diffuse gamma-ray spectrum' is currently being measured by the International Gamma-Ray Astrophysics Laboratory, a spacecraft operated by the European Space Agency.

Other fingerprints might show up in the cosmic abundances of light elements, such as lithium, formed in the Big Bang, and in deviations from perfect uniformity of the background microwave radiation, the afterglow of creation[2].

"When my collaborators and I first started thinking about super-WIMP dark matter, we were convinced that it was either completely excluded, or completely untestable", says Feng. "But it appears that we were wrong on both counts," he admits.

Gravitinos and gravitons

The super-WIMPs proposal is no exercise in pessimism. It is an exploration of the consequences of theories that try to unite quantum mechanics with gravity —one of the central challenges for modern physics.

Feng and his colleagues show that two of the favourite theories —supergravity, which invokes a whole generation of new fundamental particles, and Kaluza-Klein theories, which postulate extra hidden dimensions to the Universe —produce gravitational particles called, respectively, gravitinos and gravitons.

These hypothetical particles, say the researchers, could have precisely the properties expected of super-WIMPs: a large mass but almost zero propensity to interact with matter.

References

1. Feng, J. L., Rajaraman, A. & Takayama, F. Superweakly interacting massive particles. Physical Review Letters, **91,** 011302, (2003).**| Article |**
2. Feng, J. L., Rajaraman, A. & Takayama, F. SuperWIMP dark matter signals from the early universe. Preprint, http://xxx.arxiv.org/abs/hep-ph/0306024 (2003).**| Article |**

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