Dark Matters

Sometimes the pursuit of a great discovery is its own reward

BY LAWRENCE M. KRAUSS

Even as scientists and politicians from around the world debated in December how to deal with a practical problem of profound importance—global climate change—another international group of physicists was waiting with bated breath for a more esoteric development. In both cases, at the conclusion of events, the participants were left salivating and unsatisfied.

The Cryogenic Dark Matter Search (CDMS) experiment, located in the deep Soudan mine in Minnesota, is designed to directly detect new elementary particles that might make up the dark matter known to dominate our galaxy. In early December rumors started circulating that the CDMS experiment might actually have seen a signal.

To appreciate the significance of such an event, one needs to recognize that scientists have spent the past 40 years building a magnificent theoretical house of cards that could have toppled with the slightest whiff of inconsistent data. In the 1970s evidence began to accumulate from observations of our galaxy's rotation that there was perhaps 10 times as much invisible as visible material out there. Although mundane explanations for such material—from snowballs to planets to cold gas—at first seemed possible, gradually it became clear that none of these could fit the bill. Meanwhile independent calculations of the abundance of light elements expected to be produced in the first minutes after the big bang implied that the universe simply lacked enough protons and neutrons to account for this dark matter if the predictions were to agree with observations.

Similarly independent computer calculations about the formation of galaxies as the universe expanded suggested that only some new kind of material, which did not interact as normal matter does, could collapse early enough to lead to the structures we see.

The past 50 years of particle physics has also driven us to realize that for what we see to make sense, a host of new elementary particles quite likely exists. If so, theorists have determined that the earliest moments of the fiery big bang could have produced these particles in precisely the abundance to account for dark matter, and their interactions with normal matter would have been weak enough to make them invisible to telescopes today.

Egged on by the suggestion that such new dark matter particles in our galactic halo might be directly detectable, a brave set of experimentalists began to devise techniques to observe them with detectors deep underground, far from the reach of most cosmic rays that would overwhelm such acute sensors.

When we first proposed those experiments more than 25 years ago, I had expected that within a decade we would have the answer. But technologies at the forefront take time to build and develop, and nature rarely reveals its secrets willingly.

So after a generation of anticipation, when the physics community heard rumors that the CDMS experiment had detected something, we tuned in to the online announcement as if it were a Beatles reunion concert. It is an unreal feeling, if you are a theorist like me, to imagine that nature might actually obey the delicate theories and fanciful ideas you develop at your desk late at night on scraps of paper or at a computer screen.

The actual announcement was disappointing, however: just two pulses were detected over almost a year, and they *might* have been caused by dark matter. Unfortunately, there was also about a 25 percent chance that the events were instead caused by background radioactivity.

I admit to feeling let down at the time, but months later it is easier to regain perspective. Within a year bigger detectors will turn on, and they may yet confirm the present hints to be real signals. Moreover, the hypothesized particles might yet be detected if collisions can create them at CERN's Large Hadron Collider.

If these experiments pan out, the result won't yield a better toaster or solve the problems of climate change. But it will provide remarkable vindication of the power of human imagination, combined with rigorous logic and technological know-how, to uncover hidden worlds that even half a century ago could not have been conceived. And if not, we will all just have to work harder to solve the mystery of dark matter. New challenges bring new inspiration, which isn't such a bad thing, either. ■

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