STRETCH YOUR MIND

What's the Matter? That's What Physicists in the College Are Seeking to Detect

text by FARISS SAMARRAI

ABOVE: Illustrations of a neutrino pattern

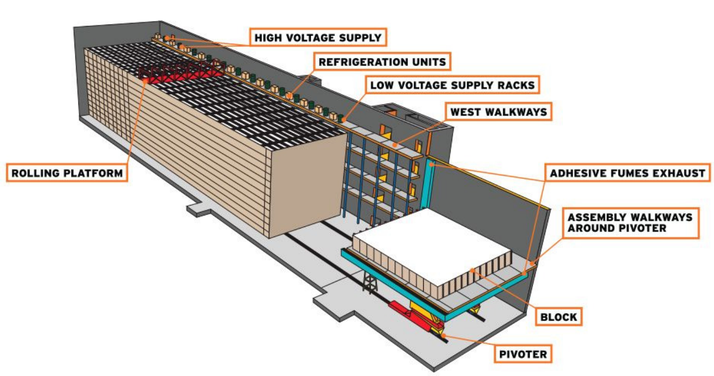
BELOW: The NOvA experiment uses two detectors: a 222 metric-ton near detector at Fermilab and a much larger 15 metric-kiloton far detector (illustrated below) in Minnesota just south of the U.S.-Canada border.

A fundamental question in physics is this: why does matter exist? Physicists theorize that in the instant after the big bang created the universe, nearly equal amounts of matter and antimatter, protons and antiprotons, neutrons and antineutrons existed. They should have annihilated each other, resulting in . . . nothing. Yet more matter than antimatter was created.

"Without this asymmetry, without this slight abundance of matter over antimatter, there would be nothing," says Craig Dukes, a physicist in the High Energy Physics Laboratory in the College. "The universe would be a boring place. There would be no stars, no planets, no people, no books. There would be no filet mignon."

Nor physicists. But the universe is made of atoms and molecules, elements and compounds. Dukes and his colleagues are trying to understand how this happened.

"We just want to know why the universe is the way it is," he says. Dukes is a member of a multi-institutional team building a $280 million, 15,000-ton detector designed to help answer the question of why matter prevailed. The detector, being built in northern Minnesota, will complement another smaller detector at the Fermi National Accelerator Laboratory (Fermilab), the national high-energy particle physics facility near Chicago.



Dukes is using a $2.5 million grant from the U.S. Department of Energy to fabricate essential components to the new detectors. "We're playing a key role that will allow us to conduct a long-running series of investigations called the NOvA Neutrino Experiment that we hope will get to the very heart of matter," Dukes says.

Physicists will investigate matter–antimatter asymmetries in neutrinos. Among the most abundant particles in the universe, neutrinos were present at the beginning of the universe; those same neutrinos remain today. These relics of the infant universe may be the source for the matter–antimatter asymmetry and may explain how things happened at the beginning.

"We will be looking at a process and then the antiprocess, how neutrinos change from one type to another," Dukes says.

To do this, scientists need two neutrino detectors; one to measure how many neutrinos are produced in a particle accelerator at Fermilab, and another much larger detector, the one in Minnesota, to capture a high-energy beam and detect how those neutrinos have changed. If neutrinos and antineutrinos change in different ways, this dissimilarity might explain the process that produced more matter than antimatter at the beginning of the universe.

The first experiments will be conducted over a six-year period, and sorting out the data will take several more years.

To learn more about the NOvA Neutrino Experiment, visit **http://www-nova.fnal.gov**.