

basic arithmetic in my head when I'm up there."

The enormous tanks—23 feet wide and more than 16 feet high—are the same kind of tanks used by Midwestern farmers to irrigate their fields. A military contractor who manufactures "light-tight" tents for soldiers in hostile territory makes the tanks' hemispherical domes.

Local workers assembled the tank array, and then made 4,000 trips by truck up and down the mountain to haul the water to fill them—a volume of 55 million liters, or the equivalent of a soda can's worth of water for each person living in Mexico.

The tanks sample the air shower particles at ground level. There are about 100 million particles in a cascade at its peak. The number of particles decreases as the cascade descends.

"It's like a pancake of high-energy particles that moves toward the ground," BenZvi says. When the particles hit the ground, they move through the tanks—and when high-energy particles move through water, they produce ultraviolet light, known as the Cherenkov effect. The photosensors in the tank record the ultraviolet light. And from the pattern of times that the sensors in each tank are triggered, scientists can reconstruct the direction of the particle pancake.

The data they collect may also shed some light, as it were, on dark matter.

"There is very strong evidence, from all kinds of measurements in astrophysics, that there is something called dark matter," BenZvi says. "But it's not clear what it is. We think it's a fundamental particle or particles."

But scientists don't know how massive it is or what its interactions are. "So it's entirely possible that some of the gamma rays and cosmic rays that we see are actually not produced by neutron stars and supernovae and things like that—they're actually produced when clumps of dark matter interact and decay. That's the idea," he says.

When anomalies are found in astrophysical data, scientists consider whether the source of the anomaly is a mistake in their model or the influence of dark matter.

"And that's kind of the name of the game," says BenZvi. "It's a tough game, as you can imagine. It's sort of like the joke about 'unknown unknowns'—you don't know what you're not modeling."

Telescopes offer another way to measure gamma rays. But they have a narrow field of view, taking in only a few degrees of the sky at a time. HAWC records information from two-thirds of the sky every 24 hours.

"Over the course of one day, we can see essentially the entire northern hemisphere," says BenZvi, noting that the methods are complementary. "We've made the bet on more coverage, less sensitivity; they make the bet on more sensitivity, less coverage. If you have both types of instruments running, you can look for unexpected stuff with HAWC—we communicate with those guys through back channels: 'Hey, we see something interesting. Point your telescope there.' And that's how a lot of the field works."

Scientists are now processing their first year's worth of data from HAWC, which they began to make public this spring. And they are expanding the array with some additional tanks—just a few, which will bring with them a four-fold increase in sensitivity.

And there is talk of creating a second observatory, possibly in Chile. The southern hemisphere provides the best vantage point for observing the center of the galaxy—and it's "a very strong candidate for observing dark matter, because we believe there's a super-massive black hole in the center of the galaxy, and so there should be a gravitational well there where dark matter is concentrated," says BenZvi.

"If we have a HAWC in the southern hemisphere, literally the center of the galaxy will be right overhead," he says.

—Kathleen McGarvey



CONVENING SCOTS: Scholars are gathering at Robbins Library to discuss texts written in Older Scots, a descendant of northern Old English that was used in medieval and early modern Scotland.

Brushing Up on Older Scots

Scholars discuss the literature of medieval and early modern Scotland.

Feeling like a *cummerworld*, or even a *dowbart*, because your Older Scots vocabulary is a bit rusty? Fear not: you needn't be looking *glaikit* for long.

In May, the University is hosting the Rochester-St Andrews Conference on Older Scots Literature and Culture. The gathering draws specialists from the United States, Canada, and Europe to share papers on 14th- to 16th-century literature in Older Scots, the descendant of Old English that was used in medieval and early modern Scotland.

Rhiannon Purdie of the University of St Andrews in Fife, Scotland, who is visiting the University's Robbins Library as a Fulbright Scottish Studies Scholar, and Thomas Hahn, professor of English, organized the event. Papers examine early literary and political texts, historiography, and language and ethnicity, among other subjects.

The Robbins Library is home to the Middle English Texts Series, sponsored by the Consortium for the Teaching of the Middle Ages. Among the nearly 100 volumes published, the series has made

Meet a Few Terms from Older Scots . . .

cummerworld: n. useless person (i.e., "encumber-world")

dowbart: n. dimwit

dreich: adj. tedious, dreary; (of weather) grey and miserable.

Still common in modern usage.

glaik: n. fool; **glaikit:** adj. idiotic

liddy: adj. slow, sluggish, indecisive

maggil, maggle: v. to spoil

maggilit: adj. mangled, ruined

nipcaik: n. miser

quean: n. wench

skaldit skaitbird: n. scabby scavenger

skamelar: n. parasite

slawsy: n. fellow, guy

walidrag: n. wastrel

available, in digital and hard copy, a number of Older Scots writings and more are in production, helping to make Older Scots literature more accessible to teachers and students around the world.

More information about the conference is on its website: Olderscots.com.

—Kathleen McGarvey