Does the Cosmos Have a Direction?

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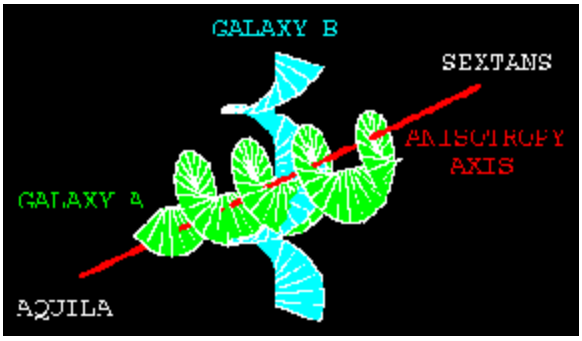

An alignment in the cosmos? The red line running between the constellations Aquila and Sextans, with Earth at its center, indicates a special direction in space. The polarization of radio waves emitted by galaxy A, which lies nearly parallel to this axis, rotates more (green corkscrew) on the journey toward Earth than does the polarization of radio waves from galaxy B (blue), which lies in a nearly perpendicular direction.
Nodland

East side, west side, all around the cosmos: No matter which way an observer looks, the vast reaches of space appear the same. Indeed, direction is meaningless in the simplest version of the Big Bang model, which holds that the primordial universe expanded uniformly, like a perfectly spherical balloon.

A controversial report now challenges that long-held tenet. An analysis of the polarization of radio waves emitted by distant galaxies suggests that the universe may have a preferred direction after all.

"This work defies the notion that there is no up or down in space," says Borge Nodland of the University of Rochester (N.Y.). He and John P. Ralston of the University of Kansas in Lawrence describe their analysis in the April 21 *Physical Review Letters*.

The results of the study, if verified, could have startling consequences. One possibility is that the Big Bang gave rise to a nonuniform distribution of matter and a somewhat lopsided expansion. Alternatively, the interaction of electromagnetic radiation with some kind of exotic, unknown elementary particle might produce a preferred direction in space.

Several cosmologists dismiss the study out of hand. They argue that the report represents a premature effort by two theorists searching for a subtle effect among a disparate set of observations gathered in the 1970s and 1980s by radio astronomers using a variety of telescopes. Many of the observations predate high-resolution, multiple-array radio telescopes. However, Philipp P. Kronberg of the University of Toronto, who studies polarization and some years ago disproved a similar claim about the universe (SN: 8/7/82, p. 84), says that the new work appears to be on a sound footing.

In their study, theoretical physicists Nodland and Ralston reviewed the measured polarization of radio waves emitted by 160 distant galaxies. The original observations were designed to measure Faraday rotation, a well-documented effect in which intergalactic magnetic fields rotate the angle of polarization of waves traveling through them. But the physicists say they have found an extra twist.

Galaxies that lie along a particular direction in space show significantly greater polarization of their radio waves than do galaxies in any other direction.

From Earth, this axis runs toward the constellation Sextans in one direction and the constellation Aquila in the other. The effect is more pronounced among the more distant galaxies in the sample, the researchers note.

"I really think this is much ado about nothing," says cosmologist Michael S. Turner of the University of Chicago and the Fermi National Accelerator Laboratory in Batavia, Ill. "The number one rule in astronomy is that you can't reanalyze someone else's data to look for an effect that [the observations] were not designed to measure."

Kronberg disagrees. "They have seen a statistically significant effect, and it raises a flag that there is something of fundamental interest here, and it ought to be rechecked, as they say in their paper."

Turner emphasizes that the existence of a special direction in space does not violate Einstein's theory of general relativity, which allows for a multitude of nonuniform universes. David N. Spergel of Princeton University says the finding appears to be at odds with measurements of the cosmic microwave background, the whisper of radiation left over from the Big Bang. The tiny fluctuations in that uniform background would seem to be inconsistent with a lopsided cosmos, he says.

From *Science News*, Vol. 151, No. 17, Apr. 26, 1997.