A simple survey yields a cosmic conundrum

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A survey of galaxies observed along the sightlines to quasars and gamma-ray bursts--both extremely luminous, distant objects--has revealed a puzzling inconsistency. Galaxies appear to be four times more common in the direction of gamma-ray bursts than in the direction of quasars.

Quasars are thought to be powered by accretion of material onto supermassive black holes in the centers of distant galaxies. Gamma-ray bursts, the death throes of massive stars, are the most energetic explosions in the universe. But there is no reason to expect galaxies in the foreground to have any association with these background light sources.

"The result contradicts our basic concepts of cosmology, and we are struggling to explain it," said Jason X. Prochaska, associate professor of astronomy and astrophysics at the University of California, Santa Cruz.

Prochaska and graduate student Gabriel Prochter led the survey, which used data from NASA's Swift satellite to obtain observations of the transient, bright afterglows of long-duration gamma-ray bursts (GRBs). They described their findings in a paper submitted for publication in Astrophysical Journal Letters. The paper, which could have strange cosmological implications, has been a source of significant debate among astronomers throughout the world.

The study is based on a fairly straightforward concept. When light from a GRB or a quasar passes through a foreground galaxy, the absorption of certain wavelengths of light by gas associated with the galaxy creates a

characteristic signature in the spectrum of light from the distant object. This provides a marker for the presence of a galaxy in front of the object, even if the galaxy itself is too faint to observe directly.

Prochter and Prochaska analyzed 15 GRBs in the new study and found strong absorption signatures indicating the presence of galaxies along 14 GRB sightlines. They had previously used data from the Sloan Digital Sky Survey (SDSS) to determine the incidence of galaxies along the sightlines to quasars. Based on the quasar study, they would have predicted only 3.8 galaxies instead of the 14 detected along the GRB sightlines.

The quasar analysis was based on more than 50,000 SDSS observations, so the data for quasars are much more robust statistically than the data for GRBs, Prochaska said. Nevertheless, the probability that their results are just a statistical fluke is less than about one in 10,000, he said.

The researchers examined three potential explanations for the inconsistency. The first is obscuration of some quasars by dust in galaxies. The idea is that if a quasar is behind a dusty galaxy it wouldn't be seen, and this could skew the results. "The counter argument is that with this huge database of quasar observations, the effect of dust has been well characterized and it should be minimal," Prochter said.

Another possibility is that the absorption lines in the GRB spectra are from gas ejected by the GRBs themselves, rather than from gas in intervening galaxies. But in nearly every case when researchers have taken a closer look in the direction of the GRB, they have in fact found a galaxy at the same position as the gas.

The third idea is that the intervening galaxy may act as a gravitational lens, enhancing the brightness of the background object, and that this effect is somehow different for GRBs than for quasars. Although

Prochaska said he prefers this explanation, several factors make strong lensing of the GRBs seem unlikely.

"Those who know more about gravitational lensing than I do tell me it's unlikely to be the answer," Prochaska said.

The paper, a draft of which has been posted on an Internet server for several weeks, has stimulated widespread discussion and at least one new paper proposing a potential explanation. But so far the findings remain perplexing.

"A lot of people have been scratching their heads, and most hope that it goes away," Prochaska said. "The GRB sample is small, so we would like to triple or quadruple the number in our analysis. That should happen during Swift's extended mission, but it will take time."

Source: University of California - Santa Cruz