Astronomy

Ron Cowen reports from Phoenix at a meeting of the American Astronomical Society

Supernova helps measure the cosmos

Observations of stellar eruptions billions of light-years from Earth can help determine whether the cosmos will expand forever or eventually collapse. The recent discovery of the most distant supernova explosion known is moving astronomers closer to forecasting the evolution of the cosmos.

Researchers observed the faraway supernova last April with the Isaac Newton telescope in the Canary Islands, Spain. The explosion took place in a galaxy some 5 billion light-years from Earth, meaning that light from the supernova took 5 billion years to reach terrestrial telescopes. The most distant supernova previously detected was located about 4 billion light-years from Earth.

Researchers strongly suspect that the distant supernova belongs to a special class known as 1A, triggered when mass is dumped onto a white dwarf star. All 1A supernovas attain the same peak intrinsic brightness – the brightness they would appear to have if an observer were standing right in front of them. Thus, knowing that the luminosity of a star declines in proportion to the square of its distance from Earth, astronomers can use type 1A supernovas as yardsticks to measure several key parameters of the age and expansion of the universe.

One of these numbers is the deceleration parameter, q_o. This parameter indicates whether clumps of matter in the universe will continue to move apart fast enough to escape gravity or whether the overall density of the cosmos is so great that it has begun to put the brakes on the expanding universe, dooming the universe to eventual collapse.

Saul Perlmutter of the University of California, Berkeley, and Lawrence Berkeley Laboratory and his colleagues caution that they aren't positive the supernova they observed is a 1A. Moreover, the amount of dust that lies between the supernova and Earth is uncertain, which could confound measurements by making the explosion appear dimmer – and thus more distant – than it really is. But at the moment, their best estimate is that the deceleration parameter seems consistent with a universe poised between permanent expansion and collapse – a model popular among theorists.

Perlmutter says that his team is searching for other distant, 1A supernovas. In comparing these faraway outbursts with the newly discovered explosion, the team hopes to find a much more definitive value for the deceleration parameter.

New evidence of Milky Way black hole

Using an infrared spectrometer to measure the velocity of faint stars near the core of our galaxy, astronomers have found that stars within 0.7 light-year of the center move 100 times faster than those twice as far away. The large increase in velocity towards the center indicates that a compact object exerting an unusually large gravitational tug must lie within 0.7 light-year of the Milky Way's core. The finding, says Joseph W. Haller of the University of Arizona in Tucson, gives new support to the notion that a black hole with a mass 1 million times that of the sun lurks at our galaxy's center.

In a separate study, researchers have for the first time directly detected infrared emissions from a compact radio source, Sagittarius A*, which has been identified as a candidate for the black hole thought to lie at our galaxy's center. Laird M. Close and his colleagues at the University of Arizona used an adaptive optics system, which compensates for the blurriness of the atmosphere, to detect infrared emissions from the star-packed region within 1.5 light-years of the center of the Milky Way. That region contains Sagittarius A*, and researchers had been puzzled as to why the radio source, which also emits gamma rays and X-rays, did not emit infrared light. The new detection strengthens the argument that the compact source is indeed a black hole, Close says.

Computers

Juggling at the speed of light

Researchers have now demonstrated what they describe as the first general-purpose optical computer. This maze of lasers, switches, and optical fibers occupies a space about the size of a desk, stores programs, processes data, and calculates using light instead of electricity. Information inside the computer circulates continually in the form of light pulses – except during the brief periods when light pulses are converted into electrical pulses to activate optical switches.

"Previous work in optical computing had not incorporated the stored program, although there have been optical processors," says Harry F. Jordan of the Optoelectronic Computing Systems Center at the University of Colorado at Boulder, who along with Vincent P. Heuring heads the development team there. The researchers can program their optical computer to multiply numbers and perform other simple operations.

"Our computer has [roughly] the power of a mid-60s minicomputer," Jordan notes. "It's got a very small memory, so only simple programs can fit into the machine – but they are stored and interpreted optically. It demonstrates the principle that all of the components of a general-purpose machine can be done in optics."

The optical computer's most striking feature is that no data are ever stored – even temporarily – in particular locations in a memory chip, as they would be in an electronic computer. Instead, information circulates as light pulses through optical fiber loops. "For the first time, we have a computer in which the program and data are always on the fly in the form of light, eliminating the need for static storage," Jordan says. He compares this mode of operation to a square dance, in which everyone is moving and partners must wait until they're next to each other to do the required figure.

With its instructions and data encoded as hundreds of thousands of light pulses, the computer has nearly 5 kilometers of optical fiber serving as its main memory. It also has 66 optical switches. During processing, infrared laser beams route light pulses from memory through the switches.

Imitating human conversation

The challenge to computer programmers was to write software that could fool human judges into thinking they were conversing with another person rather than a computer. Last month, Joseph Weintraub of Thinking Software in Woodside, N.Y., won the contest with a quirky, wisecracking, opinionated program that meanders through a discussion of differences between men and women. His entry fooled two of eight judges into believing it was a person. Weintraub, using a different program, had also won the first competition, held in 1991.

The 1992 contest, organized by the Cambridge (Mass.) Center for Behavioral Studies, featured three computer programs selected from a larger number of entries. Knowing only that at least two terminals were controlled by people and at least two were controlled by computers, the eight judges individually spent 15 minutes at each of six computer terminals, typing in questions and viewing responses. The judges then ranked the contestants from "least human" to "most human" and drew a line showing where they believed the division between human and computer lay. Although terminals operated by people scored much higher overall than those operated by software, individual judges in a few cases mistook people for computer programs and computer programs for people.

Contest director Robert Epstein and his co-workers are now organizing the next competition, set for September. "This year, we're going to see another slight improvement in the quality of the programs," Epstein says. Gradually, "the gap between people and computers in [this] test will get smaller and smaller."