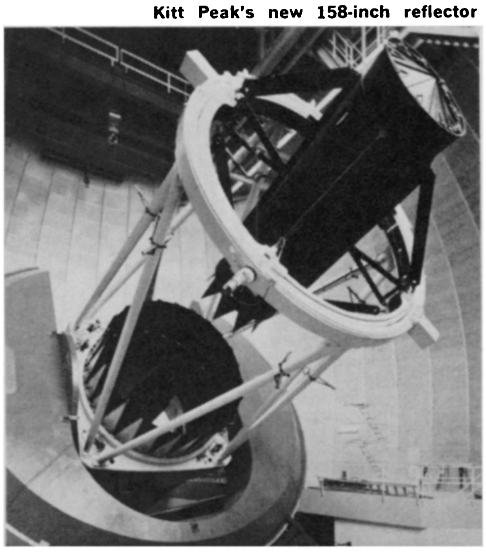
Great Nebula in Orion (Hale Observatories/100-inch)

The Majestic, Unfathomable Universe

by Dietrick E. Thomsen

Astronomy is the oldest of the physical sciences, perhaps the human race's oldest science. When our early ancestors first began to make systematic observations of celestial phenomena is unknown, but arguments are made that the menhirs, patterns of stones erected in Western Europe thousands of years ago, of which Stonehenge is the most famous example, were astronomical computers or astronomical filing systems. All recorded civilizations have studied the heavens and computed the recurrences of such things as eclipses and planetary positions. Although the main reason for compiling the information was fortune-telling, ancient astronomers developed a sophisticated understanding of celestial appearances (if not celestial mechanics), which they bequeathed to their successors.

Kitt Peak's new 158-inch reflector

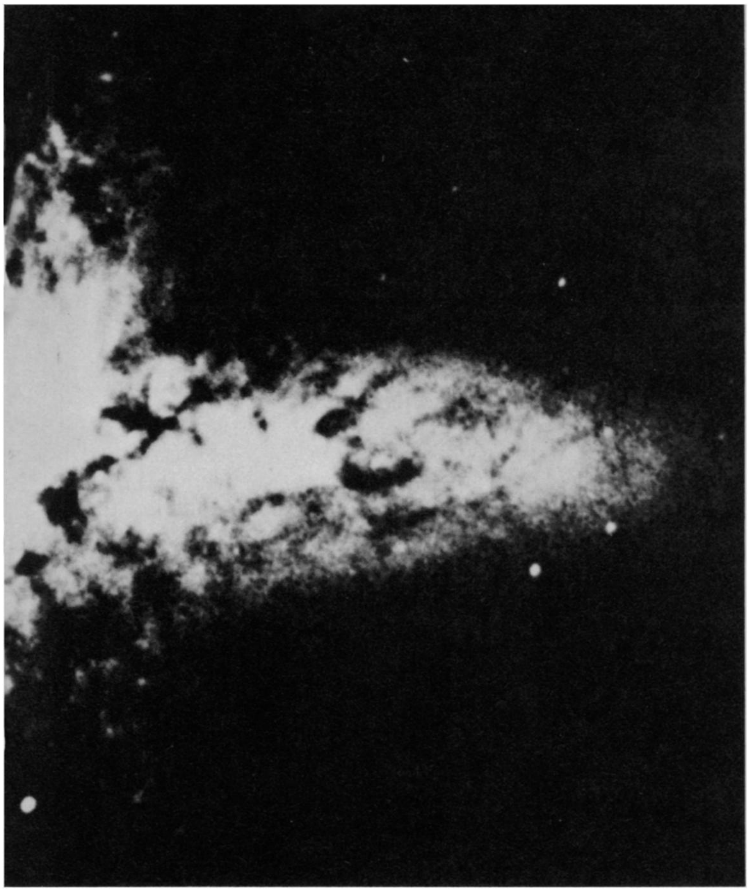


Modern astronomy began with the application of scientific modes of thought and telescopic means of observation in the hands of such people as Copernicus, Galileo, Brahe, Kepler (though Kepler too was called upon to tell fortunes) and Newton. We are now in a period that could be called postmodern astronomy, witnessing the progress of a revolution begun theoretically by Einstein and Friedmann and observationally by Hubble. It asks again and in different terms the age-old question that may have animated the minds of the prehistoric people who first piled up the menhirs and certainly occurred to the ancient astronomers of the historic period: What sort of universe do we live in; what is its shape and size and form, and what are its laws?

Concurrently another astronomical revolution has been taking place, one that extends and complicates the other. It is the extension of observations to regions of the electromagnetic spectrum invisible to human eyes, the radio, the X-ray, the infrared, the ultraviolet. The extension has led to the discovery of new classes of objects that extend and complicate the basic cosmological and astrophysical problems.

Quasars are a case in point. Without radio astronomy their peculiarity might well never have been discovered. The peculiarity is that although quasars look as compact as stars, they radiate energy in amounts proper to whole galaxies and even more. Cosmologists want to know where the quasars are and what they have to say about the size and shape of the universe. Astrophysicists (often the same people) want to know what they are, what produces their tremendous energy.

Many answers have been suggested to the questions. Not one of them is uncontroverted. If quasars are as far away as the redshifts in their light would lead people to believe, then they are some of the most distant objects ever seen. With them we are looking billions of years into the past, seeing glimpses of what the universe looked like then. If space is indeed curved in the right way, as we continue to look farther and farther out, we may eventually see the back of our own heads



Exploding galaxy M-82 (Hale Observatories)

The Lagoon Nebula (Kitt Peak Nat'l. Observatory/158-inch)

The more astronomers try to solve old problems, the more new ones they find

or whatever stood in the place of our heads 12 billion or 13 billion years or so ago.

Some astronomers argue that the quasars are nearer by and that the redshifts are due to causes that have nothing to do with distance. If that is true then one must ask: What processes are responsible? Some cosmologists suggest that unknown laws of physics may be at work. This is a radical conclusion to draw, and most astrophysicists shy from it. If it is true it will open a whole new can of worms for science.

The universe, as Hubble found, appears to be expanding. Has it always been expanding, and did it start from a zero point of time and space some 10 billion years ago, give or take a few billion? Or does it alternately expand and contract? Radio astronomy has furnished what many see as a relic of the initial period: a cosmic background flux of radio waves that seem to represent a blackbody at a temperature of 2.7 degrees K. This is generally held to be radiation that comes from the original big bang and has cooled over the ages from a temperature of billions of degrees. Cosmologists ask what were conditions in that fireball? Are there any other relics that could help to test models of one kind or another? The abundance of cosmic deuterium may be such a criterion. Estimates of its abundance are just beginning to be made.

After the big bang, what next? When and how did galaxies begin to form? Severe dynamical problems surround any attempt to answer the question. How do stars form and what is their beginning like? Infrared gives observers the capacity to look closer at stellar beginnings than they ever could before. Astronomers concentrate their view on gas clouds where stars appear to be forming now, hoping to find some answers. They ask whether planetary systems condense from interstellar clouds along with their central stars. The new science of astrochemistry or molecular astronomy has found dozens of chemical compounds in the interstellar clouds. There is complicated chemistry going on there, and it may indicate that interstellar clouds also house the beginnings of chemistry. It could be that these compounds condense into planets without being dissociated. The origin of life or at least the origin of biochemistry may lie in the clouds.

And what of the other end of the stellar biography, the demise of stars? In the pulsars some observers see neutron stars, one of the possible dead ends of stellar evolution. Then there are the mysterious X-ray sources, so recently discovered that speculations about them still partake of a certain natural vagueness. Could these, or some of them at least, be the other possible end of a star's life story: black holes, objects so collapsed that neither matter nor radiation can escape, bottomless pits down which endless amounts of matter can be thrown? (The X-rays we record would come from matter falling into the hole, not the hole itself.) Some even suggest that the whole universe is a black hole; that we are living in the middle of one.

Answers to all these questions are being sought. If they come, it will be out of the continual hubbub and twisting and turning of observation, argument and counterargument. Scientific progress never proceeds in the clean straight lines of a textbook presentation. It is now more than a decade since the late Otto Struve wrote an article entitled "Astronomers in Turmoil." They are still in turmoil, even more so than when Struve wrote. The science has never had so many loose ends. Or so many exciting challenges. □