Harvard College Observatory

One gem of the southern sky—the Small Magellanic Cloud.

GALACTIC ASTRONOMY

Magellanic Clouds—gateway to the cosmos

The Large and Small Clouds of Magellan serve astronomers and astrophysicists as a stepping stone to the universe

by Ann Ewing

For astronomers and astrophysicists, the two Magellanic Clouds, large and small, serve as a stepping stone to the universe. They are a pair of stellar systems of near-galactic size, located so close to the Milky Way that they are the most easily studied of all galaxies.

Many astronomers believe the Magellanic Clouds are among the most scientifically fruitful of all celestial objects since they are, cosmically speaking, in the Milky Way's back yard. On a moonless night, the Clouds appear almost like pieces of the Milky Way that have become detached. They can be seen only from the Southern Hemisphere, and rival all celestial objects for beauty visible to the naked eye.

That galaxies could or should have satellites has been suggested by astronomers for many years. That our Milky Way galaxy is part of a local grouping of 17 galaxies is generally accepted, and the Magellanic Clouds are usually considered satellite systems of our stellar system.

Two astronomers from Massachusetts Institute of Technology, Drs. Alar Toomre and Christopher Hunter, have calculated the paths the Large and Small Magellanic Clouds might have had hundreds of millions of years ago as satellites of the Milky Way.

Their tentative conclusion, reported to the American Astronomical Society, is that both came sufficiently close to this galaxy to distort its shape, which is basically flat, so that one outer edge tends to bend up slightly, the other to bend down, somewhat like a pancake cooked in an uneven pan.

Drs. Toomre and Hunter found that the warped edge of the Milky Way could be accounted for as the remnant of a tide raised during a close passage of at least the Large Magellanic Cloud about 500 million years ago. Although it may not actually have penetrated the galaxy, it did make a close brush, they believe, coming within 65,000 light years of the center.

Such a galactic fender denting, as it has been termed, actually involved only the long-range interplay of gravitational forces, seemingly resulting in the distortion of the Milky Way's gaseous fringe.

Dr. Toomre is still working out details of the orbit, since he and Dr. Hunter have not yet been able to determine whether the path of the Cloud during its close passage was in the same plane as the Milky Way or overhead with respect to it. They hope to resolve this ambiguity within the next two months and will then submit the details of their calculations to the ASTROPHYSICAL JOURNAL.

The Milky Way may also have a different type of satellite, Dr. Frank J. Kerr of the University of Maryland proposes.

High velocity hydrogen clouds have long been observed at high galactic latitudes and are widely reputed to be material falling into the Milky Way's disk from outside. Dr. Kerr has another interpretation—he believes they too could be satellites of the Milky Way.

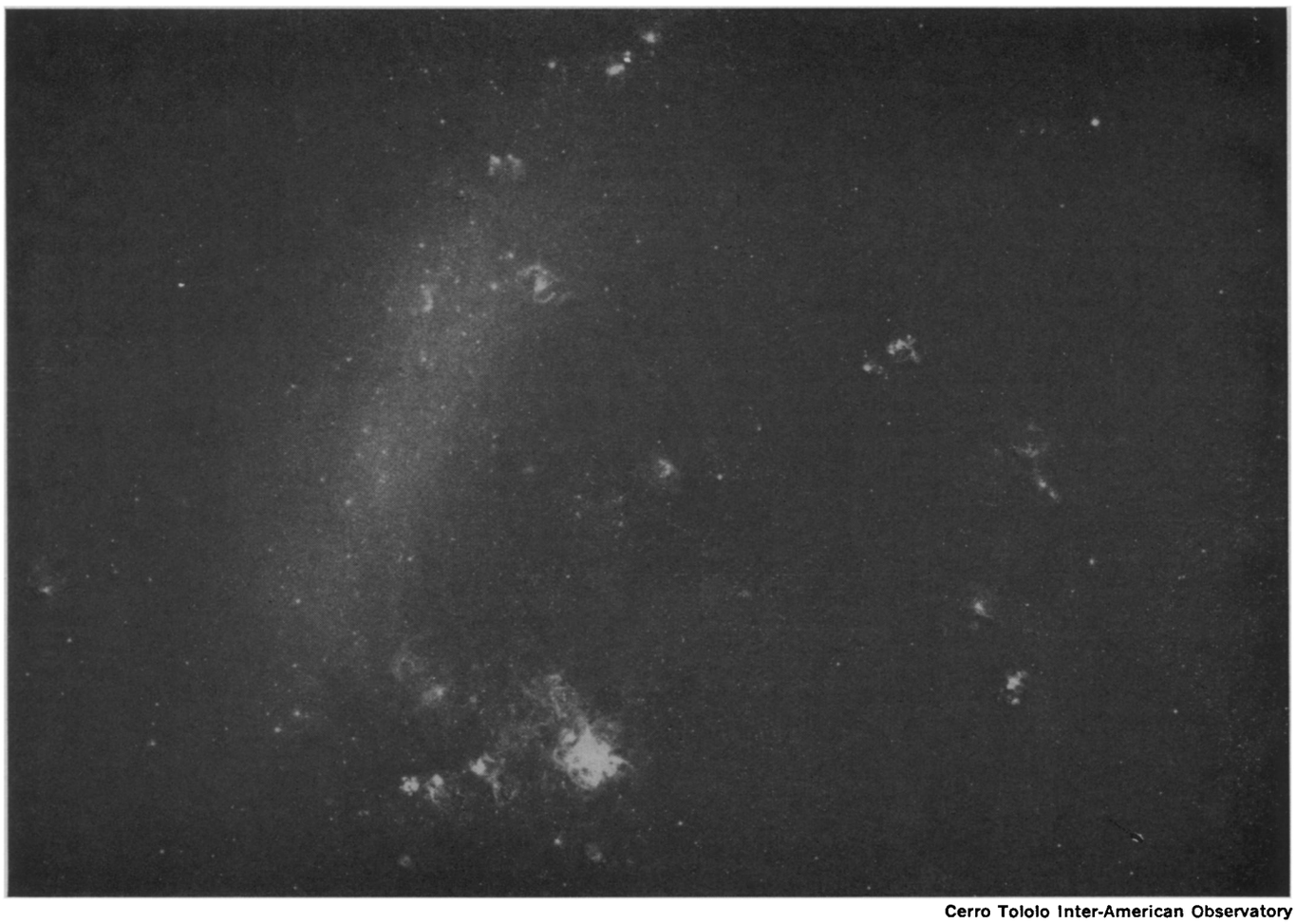
His reasoning is that, although the velocities of these neutral hydrogen clouds are known, their distances are not. They could be very near or very far away. After correcting the measured radial velocities for the galactic rotation of the sun, about 250 kilometers per second, he plotted the individual velocities against galactic longitude.

The plotted points agree well with the velocity and latitude characteristics of computations for elliptical orbits around the Milky Way made by Woodruff T. Sullivan, also of the University of Maryland.

Dr. Kerr suggests as a result of this study that the clouds are "satellite objects at distances comparable with the distance of the Magellanic Clouds, but in the opposite direction."

Although the Clouds of Magellan bear the name of the explorer whose expedition was the first to circumnavigate of the world—he mentioned them in his logs in 1521—the Clouds were not extensively studied until the early years of this century.

For the past 50 years or so they have



Cerro Tololo Inter-American Observatory

The Large Magellanic Cloud, and its partner (left) combine to make up a double satellite of the Milky Way galaxy.

been recognized as unique astronomical resources, of vital importance to modern astronomical and astrophysical research because of their relative nearness. They are only about 180,000 light years away, a tenth of the distance of the Great Nebula in Andromeda, the nearest spiral galaxy.

In the enthusiastic word of Dr. Bart J. Bok, director of the University of Arizona's Steward Observatory and a long-time champion of Southern Hemisphere astronomy:

"In investigating the Clouds, a telescope with a mirror 20 inches in diameter would equal, for galaxies at the distance of the Andromeda Nebula, the performance of a 200-inch reflector.

"One can thus see why an astronomer's eyes glisten when he considers what a 150-inch reflector in the Southern Hemisphere might do for astronomical research."

At least one such instrument is now more than a gleam. An order has been placed for a 150-inch reflector to be installed at Cerro Tololo Inter-American Observatory in Chile, a joint project of the National Science Foundation and Ford Foundation. It will be a twin of the 150-inch at Arizona's Kitt Peak Observatory, and, like it, administered by the Association of Universities for Research in Astronomy, Inc.

The 150-inch in the Chilean Andes will be the largest in the Southern Hemisphere. The Australians and the British are also building a 150-inch scope at Siding Springs, New South Wales, and there are reports that several European nations are seriously interested in erecting an instrument of the same size somewhere in the Southern Hemisphere, probably Africa.

Dr. Bok notes that the Clouds of Magellan have another major attraction besides their proximity—they are not obscured by the cosmic dust that blocks the view from earth of much of the Milky Way's star-rich central plane.

Australian radio astronomers have made extensive studies of the Clouds. Their observations show that a considerable fraction of the total mass of each Cloud is in the form of free interstellar hydrogen, indicating an adequate supply of interstellar gas for star formation. Their studies have also shown that both Clouds are rotating, an apparent requisite for stellar evolution.

Although both Clouds have a liberal sprinkling of newborn stars and star groups, the main body of both Clouds, as in the main body of the Milky Way system, consists primarily of older stars.

As Dr. Bok has noted: "Nowhere in the universe do we find young and old groupings laid out so neatly side by side as they are in the Large Magellanic Cloud. The unsurpassed richness in star groupings of widely differing evolutionary types, and of stars in all stages of development, makes the Large Cloud the external star system most urgently in need of full study."

Among the research fields astronomers have investigated and will continue to study both in light and radio waves, using the Large Magellanic Cloud as a laboratory, are the distance scale of the universe, the intrinsic properties of stars of high luminosity, the Cepheid variables and their physical properties, the chemical composition of stars, the stellar evolution pattern with particular attention to their ages and compositions, and the processes of star formation and galactic evolution.

Astronomers studying the Large Magellanic Cloud had their work simplified last summer with the publication of a new reference work by the Smithsonian Institution, which contains 168 separate photographic charts and a historical survey of literature concerning the nature and composition of the Cloud.