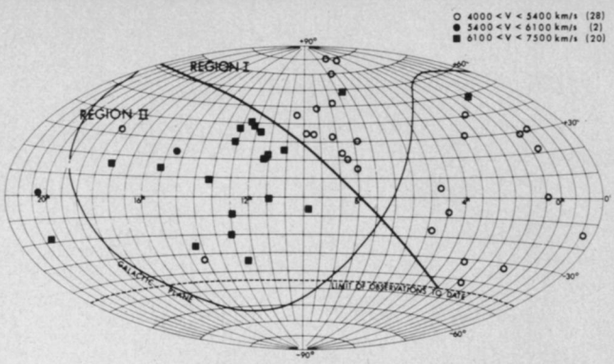

Rubin, et al./Astrophys. J.

Hubble, Hubble, Toil and Trouble

Evidence indicates the universe may not be expanding at the same rate in all directions

The proposition that we live in an expanding universe is by now well accepted. It has also generally been assumed that the expansion was proceeding roughly at the same rate in all directions. Now an indication that this assumed isotropy may not be so, at least for a group of galaxies in the middle distance, comes from an ongoing survey by Vera C. Rubin of the Carnegie Institution of Washington, W. Kent Ford Jr. of the Carnegie Institution and Kitt Peak National Observatory and Judith S. Rubin of Radcliffe College. If such a lopsided expansion were confirmed generally, it would complicate cosmologists' attempts to elucidate the geometry of the universe.

The expansion of the universe was first discovered about half a century ago by the late Edwin Hubble. In an expanding universe all points are continually increasing their distance from all other points. This means that an observer in any place in the universe will see the rest of it rushing away from him. This is what Hubble found when he began observing the distant galaxies. The light from all of them showed redshifts, and by the Doppler effect, which by then had been known for about a century, light from a source moving away from an observer will appear to that observer to be redder than it appears when the source is at rest. The redshifts thus indicated velocities of recession.

Above: Galaxies plotted by velocity. Below: NGC 5194, an Sc galaxy similar to those in survey (Hale Observatories).

In an expanding universe it also follows that the farther a point is from the observer, the faster it will appear to be receding. This principle allowed Hubble to set up a proportionality between velocity and distance. The constant of proportionality comes out as so many kilometers per second per kiloparsec and is called the Hubble constant. Though there is not yet any general agreement on its value, astronomers have generally assumed that it was the same in all directions.

The assumption is now challenged by the work of Rubin, Ford and Rubin, published in the Aug. 1 ASTROPHYSICAL JOURNAL LETTERS. It is a preliminary report of a survey that will eventually monitor 200 galaxies of the type known as ScI and calculate velocities from their redshifts. ScI galaxies are well developed spirals with bright spiral arms. They were chosen because they vary very little in absolute magnitude and thus can be used to check the isotropy of the velocity-distance relationship. (They were in fact used by Alan Sandage of the Hale Observatories in his most recent effort to evaluate the Hubble constant.) Data were or are being taken at Kitt Peak, the Lowell Observatory and the Cerro Tololo Interamerican Observatory in Chile.

The preliminary result deals with about 50 of 74 galaxies so far surveyed. It shows a strange clustering in the sky according to recession velocity. Nearly all of 28 galaxies with velocities between 4,000 and 5,400 kilometers per second turn out to be grouped in one region of the sky. Nearly all of 20 with velocities between 6,100 and 7,500 kilometers per second are grouped in another region.

The clumping by velocity is striking enough, but more striking is the absence of an expected change in apparent magnitude between the two groups. If the galaxies are all of roughly the same absolute magnitude, then the farther ones should look fainter.

One possible explanation is that the galaxies are not all fairly uniform in absolute magnitude, but that is the explanation Rubin, Ford and Rubin think least likely.

Alternately, matter in our galaxy could be absorbing the light of distant galaxies in a very lopsided way so nearer galaxies in one direction would look as faint as farther galaxies in another direction.

Or our galaxy could be moving with a peculiar motion in the direction of those that appear to be going slower, accounting for their lower apparent velocity. But a velocity of 1,000 kilometers a second is required, and that would show up in measurements of the three-degree background radiation. (It hasn't.)

Or there may be a very large-scale clumpiness of ScI galaxies, greater than any known clustering of galaxies.

There are technical reasons for doubting all the above explanations. The final explanation is that the Hubble constant varies according to the direction of view. This would mean a lopsided expansion of the universe as far as these middle-distance galaxies are concerned.

The result says nothing about what may be happening to the most distant galaxies or the quasars. Eventually, similar data can be taken for them.

Ford cautions that the findings are preliminary. It remains to be seen whether data from the whole 200 will uphold them. Nevertheless with the data now in, says Ford, "a clear enough trend" appeared to justify a preliminary publication. The three astronomers close with a quote from the late Harlow Shapley: "Obviously we are not through with this business." ——*D.E.T.*