teristic pattern, and if a source happens to be moving, the pattern will shift to the red. The individual wavelengths change, but the proportions of the pattern remain the same. When the pattern is established, the amount of redshift can be calculated.

Varshni's contention is that much of this redshift determining is done not from large patterns but from pairs of lines. This can be highly misleading because there is a good chance of misidentification of lines this way, and the ratio between the wavelengths of a pair of lines arbitrarily chosen and assigned to some emitting substance can lead to ludicrous results. He cites one example that leads to a redshift of 832. A redshift of three is considered huge.

Varshni does all this in furtherance of his contention that quasars are objects local to our galaxy and that their line emissions are due to a natural laser action. The view is highly disputed, and one of the prominent quasar people, E. Margaret Burbidge, took pains to try to shoot this contention down. The redshifts must be looked at spectroscopically, she insists, and the ones most quoted depend not simply on pairs of lines but on larger and unmistakable spectral patterns.

Finally, if the redshifts are real, there is a man, Bert W. Rust of the University of Illinois and Oak Ridge National Laboratory, who proposes that by observing events in distant galaxies, we can gain some numerical idea of the expansion of the universe. This is important too, because different cosmological theories tend to give different numbers. The events to be studied are supernova explosions. Characteristically these produce bright bursts of light that flare up suddenly and then slowly fade away. If the redshifts are doppler shifts, it follows that there should be a time lag in our view of supernova fading in distant galaxies compared with the supernovas we see nearby.

Rust has studied 36 such distant supernovas. From the way their light behaved he calculates that he can reject the classical flat Euclidean universe that our ancestors believed in with 93 percent confidence. Unfortunately the results at present don't agree very well with the usual expanding-universe hypotheses. They work best with a postulate of Irving E. Segal. This theory is so little known among astronomers that Rust had to tell them who Segal is (a mathematician at MIT).

To sum it all up, cosmology is far from settled (if we can hope that it ever will be). Observation, theory and argument bubble on. If weakening gravity is upheld, this session may have seen the beginning of an important theoretical and observational shaking out, but it will be a while before the effect is known. □

Nuclear safety: Study finds risks small

A long-awaited study of nuclear power plant safety has been released by the Atomic Energy Commission (AEC), removing from that agency what one observer calls "a rotting albatross" of 17 years duration. Like most information in the controversial nuclear power field, the report has been both attacked and praised in the week since its release.

The study, directed by Massachusetts Institute of Technology nuclear engineer Norman C. Rasmussen, focuses on the risk of accidents in commercial nuclear power plants. It was begun in 1972 and replaces a 1957 report on accident risks that has been fertile ground for nuclear critics for years. The reports differ in method and conclusion: The Rasmussen study assesses the accident risks as much lower than the earlier Brookhaven report.

Rasmussen and a technical staff of 60 scientists from the AEC, industry and universities studied the total public risks involved in the operation of 100 large pressurized water and boiling water reactors. (That number of plants is projected for U.S. operation by 1980. Fifty are currently operated.) They studied the probabilities and consequences of dozens of hypothetical accidents and found that nonnuclear accidents, both natural and man-made (plane crashes, auto accidents, etc.) are in general much more likely to occur than even minor nuclear accidents.

The likelihood of 1,000 or more fatalities occurring as a result of a major nuclear accident with 100 plants operating would be about one chance in a million per year, they found. The chance of losing that many lives by fire is 1,000 times greater; by catastrophic air crash, 5,000 times greater; by earthquake, 20,000 times greater; and by hurricane, 40,000 times greater. Large property loss, $100 million damage, was "expected" once every five centuries from nuclear accidents; similar damage from fire is experienced every two years.

A major nuclear accident would most likely involve a loss of core coolant, core meltdown and atmospheric release of radioactive gases. A nuclear explosion is considered not possible.

The 3,300-page, $3 million report was aimed in part at making accident comparisons so the general public will realize how unlikely death or injury from nuclear accidents is compared with man-made and natural risks now taken for granted. A Washington, D.C., nuclear consultant, Ralph E. Lapp, says he believes such comparisons should help end the double standard of risk assessment with regard to nuclear power. Nuclear risks are more feared and regulated than other, more likely risks, he says. Society should not pay less attention to nuclear safety, he says, but more to other areas of higher risk such as automobile and airplane safety.

The Rasmussen group emphasizes that the Brookhaven report was written during the early years of the nuclear power industry and it projected risks from limited experience with less-safe reactors. It also used inaccurate population density figures, projections of radioactive release and weather factor assessments, they say. All of these variables caused the accident probabilities to appear much higher and have added grist to critics' mills for years.

One group of nuclear critics is not impressed with the report and its new figures. Thomas Cochran and Arthur Tamplin, consulting scientists with a Washington law firm, characterize the report as "not meaningful." They charge that because the report does not consider the likelihood of sabotage, industry development past the 1980 mark and other areas of the fuel cycle such as waste storage, fuel reprocessing and transportation, "the numbers are meaningless in terms of overall public health safety." They charge that it merely confirms a preconceived viewpoint, and they are especially critical of the particular analytical methods used for risk projections (called fault tree analysis). The method concentrates on minor design comparisons and does not reveal gross design errors, Cochran says, and it can be used "backward" to arrive at preset confidence numbers. The method is valid only for comparing safety designs and not assigning overall plant risks, he says, but the Rasmussen report specifically warns against its use for comparison purposes.

An AEC scientist on the Rasmussen staff explained this apparent contradiction by saying the study combined the fault-tree method with several other more subjective analytical methods in order to gain a full picture of nuclear risks. Therefore he says the study can't be used for specific technical comparisons. The critics are forgetting these other approaches, he says.

Lapp calls such criticism "shooting from the hip." He says the Rasmussen study will be a real test for the credibility of the critics. They will have lost important ammunition (the threat of nuclear accidents) if they don't fault the study he says, but he cannot foresee any valid criticism. "One thing they forget is that we're no longer dealing with the old AEC. Madame Chairman [Dixy Lee Ray] has opened it up tremendously. This report is scarcely the technique of a stealthy group trying to force unsafe reactors down our necks." □