nothing spectacular. But once every thirty-three or sometimes thirty-four years, they produce a magnificent display which in 1966 had a peak activity of 1,000 meteors per minute at one point.

The accompanying illustration comes from a review in the first volume of *Nature* of *The Midnight Sky* by Mr Edwin Dunkin of the Royal Observatory, Greenwich (*Nature*, **1**, 215; 1869). Although not specified in the article, the woodcut could easily be of the Leonid shower maximum in 1866, and it illustrates the popular illusion that the paths of meteors are curved. It also nicely shows the way shower meteors appear to radiate from a point source in the sky.

Meteor showers are caused by streams of dust particles released by the disintegration of comets, and the explanation of the periodicity in the activity of the Leonids is a concentration of particles at a particular point on the orbit. It must be a small concentration, however, because the magnificent shower of 1966, which was widely observed across the United States, made little if any impression over Europe. It is also odd that the recurrences of 1899 and 1932 were weak compared with those in 1799, 1833, 1866 and 1966. At the time, the accepted reason was that the stream had been perturbed by the planet Jupiter, but it is hard to see how the stream could have been perturbed back again by just the right amount. An alternative explanation, equally difficult to accept, is that in 1899 and in 1933 the peak of the shower occurred over uninhabited regions or was masked by bad weather conditions. Clearly the Leonid shower is nothing if not unpredictable, which is why meteor observers will be keeping watch in the early hours of November 17.

QUASARS

Significance of Clusters

from our Observatories Correspondent

A FEW months ago Bahcall, Gunn and Schmidt (*Astrophys. J. Lett.*, **157**, L77; 1969) announced that the quasi-stellar object B 264 has the same red-shift ($z=0.09$) as a cluster of galaxies in which it is situated on the plane of the sky. Although they were cautious about the significance of their discovery, some commentators (including *Nature*'s correspondent, **223**, 1003; 1969) were confident that this discovery proved that quasars are at cosmological distances. In an article on the optical continuum energy distribution of B 264 (*Astrophys. J. Lett.*, **158**, L10; 1969) J. B. Oke has shown recently that B 264 is very similar to 3C 120, an N-type radio galaxy with a red-shift of $z=0.03$.

This object has a bright starlike nucleus with very faint outer parts. Oke surmises that if 3C 120 were three times as far away, at the same distance as B 264, then the two objects would be indistinguishable. It had already been established that B 264 has unusual properties for a quasar. It is less luminous than several of the galaxies in the surrounding cluster whereas the first quasars to be discovered, 3C 48 and 3C 273, are ten to a hundred times as luminous as the brightest normal galaxies if their red-shifts are cosmological. Furthermore, the emission lines in the spectrum of B 264 are sharp; those in "classical" quasars are remarkable for their great width. When quasars were first discovered, several astronomers pointed out their resemblance to the nuclei of certain rare galaxies—the Seyfert galaxies. At that time there was a large difference between their luminosities, however. Supposing their red-shifts to be cosmological, even the least energetic quasars were more than a hundred times as luminous as the brightest Seyfert nuclei. Three years ago the discovery of a quasar in a cluster of galaxies was considered to be a decisive test of whether or not the red-shifts are cosmological. But now the situation is more complicated. Galaxies with more luminous nuclei have been discovered as well as less luminous "quasars" such as B 264 so that there is no clear distinction between the two kinds of objects. As Oke remarks, "It is entirely possible that no physical distinction between quasi-stellar sources and N-type or Seyfert galaxies is relevant in the luminosity range where they overlap".

As a result of the recent work on B 264, astronomers on both sides of the controversy now see that it will be very hard to settle the principal point at issue—whether the very large quasar red-shifts, those greater than $z\simeq1$, are cosmological or intrinsic. It is impossible to detect clusters of galaxies at red-shifts beyond about $z\simeq0.5$ with current techniques. One possibility, not so far tried, is to show that the objects with large red-shifts are at least behind clusters of galaxies in the same part of the sky. To do this it will be necessary to find absorption lines in the spectrum of a quasar due to gas in an intervening cluster of galaxies. Several large red-shift quasars are known with absorption lines in their spectra; in some cases objects have as many as five different absorption red-shifts, all lower than or approximately equal to the emission line red-shift. These absorption lines could be due to intervening clusters of galaxies. On the other hand, they could also be due to discrete clouds of material ejected at very high velocities (up to $0.6c$ in the most extreme case) from the quasar itself; the Burbidges favour this second alternative (*Nature*, **224**, 21; 1969). A convincing proof that the absorption lines are due to clusters of galaxies will require an identification of a cluster and a demonstration that its red-shift is the same as that of a set of absorption lines in the quasar.

INTERSTELLAR CLOUDS

Isotopic Formaldehyde

from our Astronomy Correspondent

ONE of the surprising turns taken by astronomy in the past year has been the way the study of the constituents of interstellar space has become almost overnight as much the province of the chemist as of the astronomer. The particular problem is the nature of the interstellar material—gas and dust—which is aggregated into clouds. Part of the reason, of course, is the suspicion that the clouds play an important part in the evolution of the galaxy, if not of the universe. Much depends on the composition of the clouds, and on the way their properties change if the temperature falls low enough for the condensation of the hydrogen, which is known to be present in space, onto dust grains.

Professor Hoyle, for one, is intrigued by the notion that the evolution of the universe might be governed by the solid state processes involved in the condensation of hydrogen. Equally important has been the discovery in the past year of the existence in interstellar clouds of molecules which by the standards of