at intervals of 33 or 34 years, is now well past its 1966 peak, yet quite a passable display was visible last year over the United States, according to this month's *Sky and Telescope* (**37**, 124; 1969). Reports which have come in—chiefly from a group in Jacksonville, Florida, but also from California and Japan—speak of nearly 100 Leonid meteors during an hour of observing time at the peak of the shower. Although this is well above the normal level of activity of the Leonid shower, averaging a few meteors per hour, it is nothing compared with the 1,000 meteors per minute which were seen at its peak during 1966. Nevertheless, there is some slight surprise that last year's shower should have turned out to be in any way prominent.

The reason for the periodicity in the occurrence of brilliant displays is a concentration of meteoric particles along the Leonid orbit which intersects the Earth's orbit every 33–34 years. The inference is that the streams of dust particles in the Leonid orbit are comparatively young. Older streams, such as the Perseids, occur with roughly the same level of activity year after year, presumably because gravitational forces have had time to spread the meteoric dust around the orbit. The Leonids are important in the history of meteor science because they were one of the first showers to be associated with a comet; the orbit is the same as that of Tempel's comet (1866 I).

Because the number of meteors which are seen depends not only on weather conditions but also on the angle at which the meteoric particles enter the atmosphere, observers convert their counts to what would have been seen if the meteors had come from the zenith. The *Sky and Telescope* counts have been converted to zenithal hourly rates in this way, reaching a peak of 110 at about 11.40 UT on November 17. This is almost the same time as the peak of 1966. Counts sent to *Sky and Telescope* cover time intervals between 0600 and 2035 UT on November 17, and show some unconvincing evidence that the rate increased more sharply than it declined. The shower was above half its peak rate for six hours. Little information is available for the days before and after November 17, but the indications are that the shower was again above its normal level. It remains a puzzle that the 1966 shower was as brilliant as the Leonid displays of the nineteenth century, while the returns of 1932 and 1899 were weak. Until 1966, it was considered likely that the perturbations of the stream by Saturn and Jupiter had forever displaced the dust cloud from its collision course with the Earth.

X-RAY DIFFRACTION

Nine Years of Crystals

AT the Royal Society last week, Professor Dorothy Hodgkin gave an account of the course her researches have taken since 1960 when she was appointed to the society's Wolfson Research Professorship. The crystal analysis of medium sized molecules has taken most of her time, and her first concern for the relatives of B_{12} has given way more recently to a study of some bizarre compounds from bacteria.

Professor Hodgkin described a whole series of molecules having the corrin ring structure of B_{12}. One is a natural precursor of the B_{12} coenzyme, one has nickel at its core instead of cobalt, one has a fully aromatic ring system and one has no metal at all. This last molecule is interesting because very recently a metal-free corrin has been detected in the photosynthetic bacterium *Chromatium*.

Another molecule recently analysed contains the remarkable linkage cobalt–iodine–cobalt. It is obtained by reduction of cobyric hexamethyl ester. Professor Hodgkin lamented the meagre size of some of her corrin crystals. There are still many problems in the chemistry of these molecules, and bigger crystals would allow the use of neutron diffraction, a technique well suited to the solution of some remaining questions.

A study of peptide antibiotics has revealed some very strange molecular systems. An antibiotic from a bacterium resident in Oxford sewage contains multiple thiazole residues, some linked to pyridine. A green pigment from an unidentified streptomyces has iron bound by three nitrosophenol groups, with sodium trapped between outlying oxygen atoms. Professor Hodgkin hoped that this last molecule would be in a sense a model for insulin, the crystal structure of which has been sought by her group for some years now.

STATISTICS

The Two-armed Bandit

from our Mathematical Probability Correspondent

A TWO-ARMED bandit is two one-armed bandits. Suppose that you are playing a two-armed bandit and that at each play you are only interested in whether you win or lose. If the probabilities of winning are constant for a particular machine from one play to another, but are different between the machines and in any case are unknown to you and if, moreover, you can only remember what happened for the last r plays, what strategy should you adopt if your aim is to maximize your number of wins ? Having played on one machine when should you switch to the other machine ?

Sequential decision problems of essentially this sort occur quite frequently. A doctor may have to choose between two forms of treatment for a patient. If the treatments sometimes work and sometimes do not, and if the probabilities of success of the treatments are unknown, what decision rules should he use ?

A similar decision problem is involved in the scanning of two stochastic point processes only one of which can be observed at one time. What rules should one use if the aim is to observe as many points (events) as possible when the available record of what has been observed only extends back a fixed number of time units (finite memory) ? If there are two football matches being televised at the same time but on different channels, how should one switch between the channels in order to observe as many of the goals scored as possible ?

Robbins (*Proc. US Nat. Acad. Sci.*, **42**; 1956), Isbell (*Ann. Math. Stat.*, **30**; 1959) and Smith and Pyke (*Ann. Math. Stat.*, **36**; 1965) have developed what appear to be the best decision rules and now S. M. Samuels, in a paper called "Randomized rules for the two-armed bandit with finite memory" (*Ann. Math. Stat.*, **39**, 6; 1968), shows that, by a very simple addition to these rules, startlingly better results may be obtained. To begin with, it is better if the abstraction of the two-armed bandit is replaced by the abstraction of two coins. Suppose that when the coins are tossed, they have probabilities p_1, p_2 of coming down heads and that $p_1 > p_2$, although in fact p_1 and p_2 are