viral DNA—the *r* strand. In two kinds of experiment described in the April issue of *Cell*, Darnell and his coworkers (Weber, Jelinek & Darnell *Cell* **10**, 611; 1977; Goldberg, Weber & Darnell *Cell* **10**, 617; 1977) have shown that the synthesis of the vast majority of the giant nuclear viral RNA molecules is initiated at a specific site on the adenovirus genome. Once again nuclei were isolated, this time from cells in the late stages of infection, and RNA chains were extended by the addition *in vitro* of a few hundred labelled nucleotides. The radioactive label incorporated into the longest RNA molecules was found to hybridise only to the right hand end of the viral genome: the shortest molecules, however, hybridised preferentially to a region mapping between positions 14.5 and 19.0 on the viral genome. Thus late viral RNA complementary to the *r* strand is synthesised from one long transcription unit, with a promoter near position 14.5 and a terminator near the right hand end of the viral DNA. This conclusion is confirmed by experiments in which infected cells were exposed to ultraviolet irradiation —a treatment which causes lesions in DNA through which RNA polymerase cannot pass.

The frequency at which a particular sequence of DNA will be transcribed will therefore depend on whether a lesion is introduced between the sequence in question and its promoter. If the lesions are randomly distributed throughout the population of viral DNA molecules, transcription should decrease exponentially with distance from the promoter. Late adenoviral RNA synthesised immediately after irradiation was found to hybridise most efficiently with sequences from the left hand 30% of the viral genome and progressively less well with sequences to the right. The results indicate that a late promoter is present near the left hand end of the *r* strand of adenoviral DNA.

Taken together, both types of experiment show, first, that late in adenoviral infection, transcriptional control still occurs, and second, that the site at which RNA synthesis begins is quite specific and efficient. By contrast to the early promoters however, the late promoter near 14.5 on the *r* strand is highly polar and controls the expression of all genes to its right. The primary product of transcription is a long RNA molecule complementary to DNA sequences between 14.5 and 100, which is cleaved endonucleolytically to yield mature mRNA. The shift from the early to the late phase of adenovirus transcription must therefore involve alterations not only in the genes that are expressed but also in the method by which their expression is controlled.

Mass of Saturn's rings

from David W. Hughes

MASS is one of the more awkward quantities to measure in an astronomical context. Usually it is derived from a careful analysis of the perturbing effect the gravitational field of one body has on the orbit of another or, less satisfactorily, by simply multiplying the volume of the object by an estimate of its density. Inevitably the problems and uncertainties increase as the body becomes smaller or more tenuous, so W. I. McLaughlin and T. D. Talbot from the Jet Propulsion Laboratory, California are to be congratulated on obtaining the reasonably precise value of $(3.5\pm1.4)\times10^{24}$ g for the mass of the rings of Saturn. Their calculations have been published in a recent edition of the *Monthly Notices of the Royal Astronomical Society* (**179**, 619; 1977).

The gravitational potential around Saturn is a function of the planet's mass, size and principal moments of inertia and also of the mass, size and orbits of the rings and the satellites. A knowledge of the rate of precession of the satellite orbits enables this potential to be estimated with considerable accuracy. Reliable observations of the six inner satellites, Mimas, Enceladus, Tethys, Dione, Rhea and Titan going back as far as 1888 have been analysed by Kozai (*Annls Tokyo astr. Obs. Ser.* 2. **5**, 72; 1957) and Garcia (*Astr. J.* **77**, 684; 1972) to give the precession rates of the line joining the ascending and descending nodes and also the line joining the apsides.

Using these and also values for the masses and semi-major axes of the satellites, McLaughlin and Talbot have solved the gravitational potential energy function to give values for Saturn's J_2 and J_4 (coefficients in the power expansion of the potential energy function, J_2 being directly related to the moments of inertia about the spin axis and an axis in the equatorial plane) and for the mass of the rings and of the satellite, Rhea. The first solution they presented however did not use a model for the mass distribution inside Saturn and had only a limited usefulness as far as calculating J_4 and the ring mass goes, given the latter imprecisely as $(5\pm33)\times10^{24}$ g.

A much more meaningful solution was obtained by incorporating the results of Hubbard, Slattery and De Vito's high precision modelling of the interior of Saturn (see *Astrophys. J.* **199**, 504; 1975) which led to a direct functional relationship between J_2 and J_4. The inclusion of this gives a ring mass of $(3.5\pm1.4)\times10^{24}$ g, a mass for Rhea of $(2.7\pm0.5)\times10^{24}$ g and values of $(1.664\pm0.001)\times10^{-2}$ and $-(8.7\pm0.1)\times10^{-4}$ for J_2 and J_4. The mass obtained for the rings is very close to the value obtained by Franklin, Colombo and Cook (*Icarus* **15**, 80; 1971) who used a completely different calculation based on the observations of the location of the Cassini division which occurs between the A and B ring. They found a 1,400 km discrepancy between the observed position and that predicted by assuming that the division was due to particles orbiting at that distance being in resonance with the orbit of Mimas, and thus being quickly removed by gravitational perturbation. They concluded that the shift was caused by the self gravitation of ring B thus leading to an augmentation of its outer boarder. To cause the observed shift they calculated that the rings had to have a mass not less than 3.4×10^{24} g a value which agrees surprisingly well with the McLaughlin and Talbot values of $(3.5\pm1.4)\times10^{24}$ g.

So in a mass league of planetary companions the rings of Saturn come in ninth, behind Ganymede, Triton, Titan, Callisto, Moon, Io, Europa and Titania. Also if all the mass in the rings were put together into one satellite with a density say like that of Dione and Rhea (~2.4 g cm^{-3}) this satellite would have a radius of around 700 km.

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Following the leader

How mRNAs are cleaved from their nuclear precursors is totally unknown, but bizarre processes must be involved. The audience at the symposium was amazed, fascinated and not a little bewildered to learn that late adenovirus mRNAs are mosaic molecules consisting of sequences complementary to several non-contiguous segments of the viral genome. In every case so far examined, late adenovirus mRNAs contain at their 5′ ends about 150 nucleotides which are transcribed not from DNA sequences immediately adjacent to the structural gene, but from sequences which map at distant locations in the viral genome.

P. A. Sharp (Massachusetts Institute of Technology) and his colleagues, S. N. Berget, A. J. Berk and T. Harrison, described experiments in which purified mRNA coding for the major coat protein, hexon, was annealed to a restriction fragment (*Hind*III A) of adenoviral DNA which spans the hexon gene. When the resulting hybrids were examined by electron microscopy, only