The first comet to be recognized as periodic never came back (P/Lexell) while the first periodic comet to return displayed a motion that was not compatible with Newtonian mechanics (P/Encke). The nongravitational motion of comet Encke reintroduced the Aristotelian notion of an interplanetary ether, or resisting medium. The second periodic comet to be recovered soon split into pieces (P/Biela) and its remains were recognized as the Bielid meteor shower of 1872 - thus providing dramatic evidence that comets are responsible for meteoroid streams. The model of a comet being a collection of meteoroid particles then replaced Newton's view of them as solid bodies. Though Newton and Halley made giant strides in understanding the nature of comets, and several significant steps were made during the subsequent two centuries, there were also more than a few pratfalls - thanks to the perversity of nature.

18.03-T

The Discovery of Charon: Happy Accident or Timely Find?

R. L. Marcialis (LPL/U. of Arizona)

It is often said that the timely discovery of Pluto's satellite Charon (1978 P1) was fortuitous, coming a scant ten years (3% of an orbit) before the earth passed through the orbital plane of the satellite. I argue that the discovery was *not* serendipitous, but rather the natural result of concurrent ripening of technology and existence of favorable viewing geometry. The 1960's through 1980's spanned the years of highest detection probability.

Three major advances in astrometry had to occur before Charon detection (a pre-1965 limit). These were: the 1964 completion of the USNO 155-cm reflector, the introduction of automated measuring engines, and the reduction of exposure times. In sum, they resulted in plates with narrower point-spread functions being measured to higher precision. It became possible to resolve binaries that previously had been "burnt in" to the emulsion as a single source. (Hence the failure of Humason's 1950 Plutonian satellite search.)

Earth–Pluto–Charon geometry conspires to make discovery most likely $\lesssim$ perihelion in 1989. The Pluto–Charon angular separation is then near its maximum. Relative orientation of Pluto's orbital ellipse and Earth's axial obliquity cause Pluto to reach greatest northern declination during the inbound quarter of its orbit. Since most of the Earth's major observatories reside in the northern hemisphere, studies of Pluto are best conducted at positive declinations. The "observing window" (time per night at less than a threshold airmass) is a strong function of declination. Seasonal variation of evening twilight strengthens the argument. Although a face-on orbit is most conducive to satellite discovery, the planet was observed only rarely in the 1940's due to, among other things, the Second World War.

Session 19: Comets: General II
(H. Spinrad, Moderator)
4:10–5:30, Texas I

19.01

Properties of Mantles on Cometary Nuclei

R. Smoluchowski (Univ. of Texas)

An analysis of various aspects of the formation of a dusty mantle on an active cometary nucleus permits an assessment of its coherency and mechanical strength using various experimental and theoretical data. On a new comet emerging from the Oort cloud, the strength of the locally densified mantle is somewhat less than that of pure ice, that is perhaps 10^7 dyne cm^{-2}. Then as the ice gradually evaporates and leaves locally only a thin layer of ice between the refractory grains, the strength of the mantle goes up perhaps by a factor of ten. Finally, depending on the thermal history of the nucleus the hydrogen bonding due to the thin layer of ice is gradually replaced by much stronger ionic and covalent bonds through the process of radiation sintering. In view of the expected porosity of the mantle the final strength is probably not more than 10^8 dyne cm^{-2}. The presence of various decomposition products of the organic CHON materials may lead to additional strengthening of the mantle, through the formation of pseudographitic carbons. It may also lead to a decrease of the permeability and porosity of the mantle below the expected value of about 0.5. At high temperatures, the thermal conductivity of the mantle should be low which shows up in the high temperatures reached by its surface.

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19.02

The Accumulation and Structure of the Cometary Nucleus: The Fluffy Aggregate Model

B. D. Donn (NASA/GSFC), P. Meakin (E.I. duPont de Nemours)

This paper describes an improved version of the accumulation and structure of the cometary nucleus over those presented earlier (Donn and Hughes, ESA SP-250 III, p. 523). An ice/dust grain mixture accretes at velocities of tens of cm s^{-1} to form mm size fractal aggregates for which the density varies as R^{-1} where R is a characteristic size. Objects of several cm will have more uniform densities. Still larger fluffy aggregates will be low density, compressible cometesimals and generally coagulate on colliding. The kinetic energy of colliding bodies is dissipated by the work of compression. This process causes density variations in the growing aggregate. Using the very limited experimental data on the compression of snow and fine dust, we can compute the work of compression and the penetration depth. The density of the compressed zone can also be estimated. Penetration depth is only a fraction of the cometesimal size. For collisions with impact parameter $D \lesssim R_1/4$, where R_1 is size of the larger, coagulation occurs. For large D, depending upon kinetic energy, some degree of fragmentation results. A simplified accumulation mechanism based on fractal accretion processes will be described. In this, the dynamics of fluffy aggregate collisions replaces the assumption that particles stick upon contact. This enables the evolution of larger aggregates leading up to the comet nucleus to be traced. Preliminary results will be presented. The nucleus has an irregular shape and non-uniform density and possibly composition. Cavities appear to be smaller than previously deduced but larger than Smoluchowski's pores.

19.03-T

The Cometary Dust Trail Survey

M.V. Sykes and K. Dow (Steward Observatory/ U of A)

Dust trails are long, narrow contrail-like structures, extending several to tens of degrees along a comet's orbit. They consist of submillimeter and larger particles emitted at low velocities. Dust trails in general represent the refractory component of comet nucleus material, and provide insight into the physical properties of the comet surface. Any mantled surface on Tempel 2, for example, is predicted to be as dark as the Halley nucleus since the Tempel 2 trail material has been shown to have an albedo of a few percent. Dust trails also represent a hazard to future spacecraft designed to rendevous with comets, particularly if the comet is approached along its orbital path. A survey of 1836 IRAS skyflux images and 246 Additional Observation fields has been conducted over the past two years in order to locate and identify all cometary dust trails observed by the satellite in 1983. Preliminary results