Analytical constraints on comet nucleus rotation

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Nucleus rotation essentially affects many processes studied in cometary physics. Hypotheses on the nucleus rotation are obligatory in mathematical models being developed to solve complicated ballistic and navigation problems arising in spacecraft comet studies. Hence, it is important to realize typical parameters of nucleus rotation for various types of comets.

In the classical model of a comet nucleus suggested by Whipple [6], anisotropic ice sublimation under solar radiation produces in general reactive torque. It should result in slow variations of a nucleus' rotation parameters. In [3–5, 7] the spin evolution of comet nuclei was investigated by numerical integration of the equations of nucleus rotation. We seek to develop a more systematic approach to the problem by studying the rotational evolution of a cometary nucleus using the averaging method [1]. It allows us to extract the relevant physical parameters that control the evolution of a comet's rotation state and to describe several scenarios qualitatively different in behavior of the motion parameters.

In particular, we found that the long–term evolution of the comet's angular momentum vector is a function strongly dependent on the distribution of active regions over its surface. We obtained that the fraction of active area may lead to certain values of nutation angle and cause its angular momentum direction to align in specific directions related to its perihelion. This result can be used to discriminate between competing theories of comet outgassing based on a nucleus' rotation state. It also allows for a range of plausible *a priori* constraints to be placed on a comet's rotation state to aid in the interpretation of its outgassing structure.

According to modern ideas about the physical properties of the upper layer of a comet nuclei, standard cometary activity formulas [2], used in our studies, are very rough model of the real sublimation process. Nevertheless, it is remarkable, that this simple model allows the detailed analysis of reactive torque effects on the nucleus spin evolution.

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