MODEL OF THE COMET OUTBURSTS BASED ON A FRAGMENTATION OF ICE GRAINS IN ITS ATMOSPHERE

D.A. ANDRIENKO AND I.I. MISCHISHINA
Kiev University

Outbursts of the comet's brightness play a significant role in the study of the physical nature and evolution of comets. The causes of cometary outbursts are still not properly understood. It is known, however, that there is correlation between the outbursts and the high-velocity flux of solar wind. The evidences of such causal relationship are the following: the existence of the correlation between the geomagnetic perturbations and the outburst activity of the comets [1]; two-peaks distribution of the comet's outbursts, which depends on the 11-year solar cycle phase with maxima at phases 0.2–0.3 and 0.7–0.8, in coincidence with the distribution of physical characteristics of high-velocity fluxes [2]; the repeated character of the outbursts with main intervals of 7–8, 14–15, 22–24 and 30 days, this corresponds to the four-sector structure of the interplanetary magnetic field [3].

We think that the generation of outbursts requires the existence of some favourable internal conditions in the comet's head besides corpuscular external effects. In our model approximation, the comet nucleus is treated as a conglomerate of different ices and refractory impurities. The surface layer of such nucleus may be destructed periodically being accompanied by ejection of large icy grains into the comet's coma and forming a halo at its periphery. Similar processes of icy grain ejection were observed during comet simulation experiments performed by Kajmakov[4] and the KOSI group [5]. Due to the presence of the structural imperfections such as cracks and refractory impurities, the icy grains are unstable and may be destroyed by the energy particle of solar wind. The process of the halo's icy grain destruction results in increasing of the total reflection of the solar light, giving origin to additional atmospheric dust source and strengthening the extended gas source. The accurate solution of the behavior of the cometary brightness during the process of icy grain halo's destruction is a complex problem. But quite simple numerical simulations of the time dependence of the intensity

S. Ferraz-Mello et al. (eds.), Dynamics, Ephemerides and Astrometry of the Solar System, 221–222.

of the solar light reflected from a halo may be obtained. The following set of integro-differential equations has been combined:

$$M(t) = 4/3\pi\rho N(t) \int_0^{r_{max}} r^3 f(r,t)dr \qquad S(t) = 4\pi N(t) \int_0^{r_{max}} r^2 f(r,t)dr$$

$$\frac{dM}{dt} = -\mu S(t) \qquad \frac{dS}{dt} = 8\pi\frac{\mu-\eta}{\rho}N(t) \int_0^{r_{max}} r f(r,t)dr$$

where $M(t), S(t)$ are mass and area of icy grain halo, $N(t)$ the number of icy grains, $f(r,t)$ the size distribution function, ρ the density of grains, μ and η the sublimation and fragmentation coefficients representing the material mass sublimating or breaking away in a unit time from a unit area.

These set of equations describes the outbursts observed in the integral light. The model parameters are: a heliocentric distance R; the initial mass of halo M_0; the fragmentation coefficient; the initial grain size distribution function $f_0(r,t)$; the function variation rule with time $f(r,t)$; the albedo of halo icy grains.

The results of the model with parameters described in [6] are in good agreement with the main outbursts parameters presented in [2]. The model explains the duration of outbursts, their amplitudes and variability of these values with a heliocentric distance. At large distances, the values of the amplitude and duration are larger than those at close distances to the Sun. At small distances, the icy grain life time extremely decreases and the calculated amplitudes become smaller. With a comet having approached to the Sun, the powerful gas atmosphere is formed and the possibility of the outburst observations falls.

It is worth noting that in the model frame some different comet's phenomena may be explained such as the origin of the brightness condensations, existence of short-lived molecules at the head periphery and in the tails, the light polarization variations at different distances of nucleus and its time variability, the existence of well-developed plasma structures in heads and tails of comet with outbursts.

References

1. Richter N.B.: 1963, *The Nature of Comets.* London, Methuen.
2. Andrienko D.A., Vashchenko V.N.: 1981, *Komety i korpuskularnoje izluchenije Solntsa*, M. Nauka,164.
3. Podgorny I.M., Andrienko D.A., Kleshchenok V.V. and Mischishina I.I.: 1990. *Astro. Lett. and Communications* **28**, 33.
4. Kajmakov E.A., Lizunkova I.S.: 1982, *Kometnyj tsirkular* 194, 4.
5. Kochan H., Markiewich W.J., Keller H.U.: 1991, *Geophys. Res. Lett.* **18**(2) 273.
6. Andrienko D.A., Mischishina I.I.: 1986, *Astronomicheskyj zhurnal* **63**, L2, 335.