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Numerical simulation of a joint gas and dust expansion from a spherical source

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Abstract

In the present work we study a joint expansion of gas and dust from a spherical source with different gas-to-dust mass ratios. This problem share many similarities with dust motion in the near surface layer of a dusty-gas atmosphere of a comet.

1. Introduction

In the context of an increasing number of complex multiparametric dusty-gas coma models it is convenient to construct a set of elementary models with a minimum number of parameters selected to represent the key processes acting on the dusty gas coma. Such kind of models enables studies of generic processes occurring in variety of particular cases in order to reveal their similarity and characteristic features.

The majority of modern models of dusty-gas cometary atmospheres (e.g. [1-5]) do not take into account the influence of dust grains on the gas flow. This is justified by the assumption that dust content in the cometary atmosphere is low. But in the near surface layer, where dust still has low velocity but high concentration, the content of dust can be high and affect significantly on the gas flow. Therefore, in the present work we study the motion of gas and dust jointly in order to reveal main regularities and limiting cases of the gas flows with high content of dust.

2. The model

We study the case of steady expansion into vacuum from homogeneous spherical source given by the radius, surface temperature, gas production rate and mass. The model of gas emission from the surface (upward flux of the gas) corresponds to the sublimation process in the range of characteristic Knudsen numbers 0.01-0.0001.The dust mass flux from the surface is proportional to the gas mass flux. We assume that dust grains are isothermal spheres moving under influence of two forces: the gravitational force and the gas drag force. We study cases of monodisperse and power law dust size distributions for sizes from submicron to millimeter.

The joint gas-dust flow is computed by the Direct Simulation Monte Carlo method (DSMC) supplemented by a model of gas-dust interaction.

The parameters of simulations correspond to the conditions of the rendezvous of the Rosetta probe with the comet 67P/Churyumov-Gerasimenko. The dust content varies from the case when presence of dust does not affect the gas flow (weakly dusty atmosphere) to the case when presence of dust sufficiently affects the gas flow (dust-laden atmosphere).

3. Conclusion

We present the structure of the layer of gas and dust interaction for different contents of dust.

The models outputs can be used as a reference evaluation of these processes with rough estimates of the resulting dusty gas properties.

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References

[1] Crifo, J.-F., Loukianov, G. A., Rodionov, A. V., Zakharov, V. V.: Direct Monte Carlo and multifluid modeling of the circumnuclear dust coma. Spherical grain

dynamics revisited, Icarus, Volume 176, Issue 1, pp. 192-219., 2005.

[2] Marschall, R., et al., Modelling observations of the inner gas and dust coma of comet 67P/Churyumov-Gerasimenko using ROSINA/COPS and OSIRIS data: First results, A&A 589, A90 (2016).

[3] Rodionov, A. V., Crifo, J.-F., Szegő, K., Lagerros, J., Fulle, M.: An advanced physical model of cometary activity, Planetary and Space Science, Volume 50, Issue 10-11, pp. 983-1024, 2002.

[4] Shou, Y., et al., A New 3D Multi-fluid Dust Model: A Study of the Effects of Activity and Nucleus Rotation on Dust Grain Behavior at Comet 67P/Churyumov–Gerasimenko, The Astrophysical Journal, 850:72 (14pp), 2017.

[5] Tenishev, V., Combi, M., and Rubin, M., Numerical simulation of dust in a cometary coma: aplication to comet 67P/Churyumov-Gerasimenko, The Astrophysical Journal, 732:104 (17pp), 2011.