EPSC Abstracts
Vol. 6, EPSC-DPS2011-1793, 2011
EPSC-DPS Joint Meeting 2011

Density distribution of metal-containing species in the exosphere of Mercury after meteoroids impacts

A. A. Berezhnoy (1), **V. Mangano** (2), A. Mura (2), A. Milillo (2), and S. Orsini (2)
(1) Sternberg Astronomical Institute, Moscow, Russia; (2) INAF (Institute of Physics of Interplanetary Space), INAF, Rome, Italy (valeria.mangano@ifsi-roma.inaf.it/ tel: +39-06-45488752)

Abstract

The contribution to the exosphere of Mercury and the Moon due to meteoritic impacts is still a matter of debate. In particular, in the night side, where the ion sputtering process is negligible, meteoritic impact vaporization is considered to be the major exospheric source process for refractory species. Cloud density calculations and detection probability of meteoroids impact events for objects in the radius range between 1 cm and 1 m was considered in [1]. Detailed thermodynamic calculation of the cloud composition after quenching temperature is reached was considered in [2], but a comprehensive analysis of the meteoritic impact vaporization contribution to the hermean exosphere including condensation of refractory species and formation and photolysis of molecules in the impact-generated cloud was not performed yet. This is what will be done in the following.

1. Introduction

Based on the upper limit of Ca content in the lunar exosphere [3] and the predicted content of impact-produced Ca atoms, a fraction of Ca-containing species in the gas phase Func (Ca) (the ratio between content of Ca-containing species in the gas phase to the total amount of Ca-containing species in gas and solid phases) is estimated to be lower than 0.05 [4]. It corresponds to the upper limit of the temperature of quenching of condensation of Ca-containing species equal to 3900 K. Other elements such as Ti, Si, Fe, Mg, Na, and K form solid state species at lower temperatures (see Table 1).

Applying similar fractions of species in the gas phase for Al, Si, Fe, Mg, Ti, Na and K (see Table 1), we plan to perform Monte Carlo simulations of density distribution of metal-containing species in the exosphere of Mercury after meteoroids impacts taking into account formation and photolysis of molecules as well as condensation of refractory elements. This single-particle model was originally developed for Mercury to simulate the particles released by ion sputtering [7], and will be used to reproduce the cloud expansion after a meteoritic impact event. Photolysis-generated metal atoms receive additional energy during photolysis of metal-containing species; hence, the cloud temperature is expected to increase after quenching.

To investigate more in detail the possible behavior of molecules and photolysis-generated metal atoms, several quenching temperature of condensation will be analyzed, as well as several values of temperature of metal atoms in the impact-produced cloud.

Results will be discussed in the frame of our actual knowledge of the exosphere of Mercury and recent MESSENGER measurements.

Table 1: Fraction of species of different elements in the gas phase versus temperature of the impact-produced cloud. The initial temperature of the impact-produced cloud is 10 000 K, the initial pressure is 10 000 bar, $\gamma = 1.2$, the target-to-impactor mass ratio is 30. The elemental compositions of the impactors and the target are taken to be that of CI chondrites [5] and as mixture of 90 % plagioclase and 10 % pyroxene by volume as proposed by [6], respectively.

T, K	3000	3500	4000
Func(Ca)	0,0026	0,011	0,072
Func(Al)	8,6E-6	0,00029	0,0092
Func(Na)	1	1	1
Func(K)	1	1	1
Func(Fe)	0,068	0,62	1
Func(Si)	0,0047	0,1	1
Func(Mg)	0,027	0,35	1
Func(Ti)	1	1	1

2. Summary and Conclusions

To investigate more in detail the possible behavior of molecules and photolysis-generated metal atoms, several quenching temperature of condensation will be analyzed, as well as several values of temperature of metal atoms in the impact-produced cloud.
Results will be discussed in the frame of our actual knowledge of the exosphere of Mercury and recent MESSENGER measurements.

Acknowledgments

A.A.B. was supported by the Russian Foundation for Basic Research, project No. 11-02-90440-Ukr_f_a.

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