EPSC Abstracts
Vol. 8, EPSC2013-715, 2013
European Planetary Science Congress 2013

On the origin of the carbon atomic ion (C^+) in comet 1P/Halley measured from the Giotto Ion Mass spectrometer

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Abstract

More than twenty years after the end of the European Giotto mission, some of the results are still not clearly understood. Indeed we still don't know what is responsible for the high abundance of the C^+ ions measured by the ion mass spectrometer onboard Giotto. In this poster we will present preliminary results with our new cometary model.

1. Introduction

The last and only time that a mass spectrometer was carried on a spacecraft in order to analyze in situ the gaseous species in a cometary atmosphere was during the Giotto mission in 1986. On board the spacecraft, the Positive Ion Cluster Composition Analyser of the Rem Plasma Analyser (PICCA-RPA), the Neutral Mass Spectrometer (NMS), and the Ion Mass Spectrometer (IMS) were devoted to characterize the gaseous species of 1P/Halley's coma. One of the observations and discovery of the IMS instrument was the high abundance of atomic carbon ions (C^+) in its mass spectra [1]. Despite the numerous studies carried out about the subject, no definitive answers have been established in order to explain the measured density of this ion for all cometocentric distances [2].

2. Origin of C^+ in Halley's Coma

Many hypotheses have been proposed to explain this high abundance of C^+. The previous studies have been focused on the production of C^+ only from gaseous species. Indeed C^+ seems to originate from the photoionization of neutral atomic carbon (C). This neutral atomic carbon could be produced by numerous chemical reactions. Indeed in the inner coma of Halley, the production of C can be initiated by photodissociation of gaseous species, ion-molecule, neutral-neutral or electron impact reaction [2,3]. Several chemistry coma models have been used in order to resolve the problem of the high abundance of C^+ in 1P/Halley's coma [2, 3].

From the numerous hypothesis tested, we can conclude that the photodissociation of CO, CO_2, and H_2CO and then the photoionization of their daughter species can explain a part of the density profile of C^+ but cannot be the only contributor of this ion in the coma [2]. The origin of C^+ from the photolysis of CO, CO_2, and CH_4 leading to the production of neutral atomic carbon and then its photoionization in C^+ have also been tested. It seems that it is also not sufficient to explain completely the high abundance of C^+ in Halley's coma [1].

The only way to fit the density profile of C^+ ions below 4550 km from 1P/Halley's nucleus is to add an additional extended source of carbon into the coma chemistry model [2]. Moreover this additional source of carbon must have a short scale length in order to fit the measurement from IMS [2].

3. Objective

In this poster we will present a new study in order to explain the observed C^+ abundances in IMS. A part of the C^+ ions could be produced by the photolysis or thermal-degradation of organic compounds present in Halley's dust grains. Indeed it has already been demonstrated that thermal degradation of refractory organic compounds in cometary grains could explain the origin of certain gaseous species [5,6]. Therefore we will try to take into account the production of C^+

ions from carbonaceous compounds present on the grains ejected by 1P/Halley's nucleus and try to have a clearer idea of the organic compounds at the origin of this potential distributed source.

These results could also help us to understand and prepare the interpretation of data, which will be measured by ROSINA onboard the upcoming *in situ* cometary mission: the Rosetta mission.

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