EPSC Abstract,
Vol. 4, EPSC2009-35, 2009
European Planetary Science Congress, ©Author(s) 2009

The main features of the Martian and Venusian meteor years: An Earth-oriented assessment

A. A. Christou

Armagh Observatory (College Hill, Armagh BT61 9DG, UK (aac@arm.ac.uk / Fax: +44 2837 527174)

Introduction

The Earth's atmosphere is pummeled by streams of meteoroids at certain times of the year, giving rise to the annually-recurring phenomenon known as a *meteor shower*. The most intense showers are known to be associated with specific comets at various stages of their dynamical and physical evolution [1]. As such, showers represent free sample returns to comets at the population level. Observational campaigns are now regularly carried out during showers to determine fundamental characteristics of each stream and its parent comet (eg stream cross-section, mass distribution of grains, relative abundance of key elements) as well as the degree of diversity within the population. The same campaigns have also offered tantalising glimpses of the effects of these showers on the Terrestrial environment. These include meteoric emission of detectable ELF/VLF waves and the enhancement of the metallic atom population in the ionosphere [2].

Searching for Exo-meteors: a test based on the Terrestrial paradigm

Meteors must also occur in the Venusian and Martian atmospheres [3, 4, 5, 6, 7] but so far no direct search has been undertaken using instruments fit for the purpose. Adding those two planets to our inventory of planet-sized meteoroid detectors would greatly increase the number of comets that can be studied through their meteors. In addition, the environments of these planets are ideal natural laboratories in which to probe the diversity of meteoroid effects and test models of their production [2].

A simple test of our understanding of how meteoroid streams form is to predict which planet-approaching comets produce the dominant meteor showers at Venus and Mars. Proximity of the comet's orbit to the planet's orbit is one criterion encountered frequently in the literature [1, 5, 8, 9, 10]. However, terrestrial experience clearly indicates that it is not sufficient: for example, almost all Earth approaching Jupiter-Family Comets do not produce prominent annual showers; frequent impulsive changes to the comet's orbit by Jupiter prevent the formation of a cohesive, dense stream.

Here we have taken a different approach: using known associations (or lack thereof) between Earth approaching comets and strong meteor showers as a guide, we have defined a set of criteria that should discriminate between parents of strong and weak or non-existent showers at Venus and Mars. These criteria are: The stability and size of the comet's orbit, the intrinsic brightness of the comet, the orbital approach distance, and the speed of impact in the atmosphere. This last parameter is relevant to the case of the Martian atmosphere where the altitude of ablation is very sensitive to speed for slow meteoroids [3, 7].

Results

This procedure was applied to available cometary orbit databases to yield a shortlist of comets likely to deposit high rates of meteoroids into the atmospheres of our nearest planetary neighbours. The results exhibit a number of interesting features, two of which we discuss here:

Firstly, strong meteor showers should not be distributed evenly in solar longitude, but instead they should cluster into groups. This clustering is strongest at Venus where three major "seasons" are postulated; significant overlap between showers should occur within each season. At Mars, significantly more activity is expected for the second half of the year ($180^{o} < L_S < 360^{o}$) than the first ($0^{o} < L_S < 180^{o}$); in most cases, meteor showers should be well separated from their neighbours in time.

Secondly, we find several intrinsically bright Long Period Comets (LPCs; $H_{10} < 5$; P ~ 2000 yr) that approach Venus and Mars to within 0.01 AU, including three Great Comets of the 18th and 19th centuries. These have no counterpart at the Earth and their meteor showers, if they exist, will be of a wholly new type, offering access to LPC material in the inner solar system.

References

[1] Jenniskens, P. (2006) Meteor Showers and their Parent Comets, Cambridge University Press, New York.

[2] Christou, A. A. et al. (2007) Planet. Space Sci., 55, 2049-2062.

[3] Adolfsson, L. G. et al. (1996) Icarus, 119, 144-152.

[4] Apshtein, E. Z. et al. (1982) Cosmic Research, 20, 730-735 (in russian).

[5] Christou, A. A. et al. (2004) Icarus, 168, 23-33.

[6] McAuliffe, J. P. and Christou, A. A. (2006) Icarus, 180, 8-22.

[7] McAuliffe, J. P. and Christou, A. A. (2006) Proc. IMO Conf., 155-160.

[8] Christou, A. A. and Beurle, K. (1999) Planet. Space Sci., 47, 1475-1485.

[9] Neslusan, L. (2005) Contr. Astron. Obs. Skalnate Pleso, 35, 163-179.

[10] Selsis, F. et al. (2004) Astron. Astrophys., 416, 783-789.