The Tiny Ionosphere of the Moon Studied by virtue of the SMART-1 signals

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Summary

An exceptional opportunity to study the tiny lunar ionosphere became available in the spring of 2006. In fact the European Probe SMART-1, then in orbit around the Moon, would have crashed on the Moon surface on Sunday, September 3rd. While most scientists declared their interest to observe SMART-1 especially during its final crash, our team gathered radio data in S-band from the occultations of SMART-1 by the Moon during the week prior to the crash (August 29th thru September 3rd, 2006). These occultations were observed by virtue of the two 32-meter dishes of INAF (the Italian National Institute for Astrophysics) located in Medicina (near Bologna) and in Noto (in Sicily). This paper is an updated description of our observations, but not a model of the lunar ionosphere yet.

1 Introduction

The existence of a tiny lunar ionosphere was suggested since the 1950's/60's during the radio observations of some lunar occultations.
The SMART-1 European spacecraft not only provided a wonderful opportunity to investigate the lunar ionosphere directly again, but also to measure the attenuation of radio waves beside and behind the Moon. In fact, the radio waves emitted by SMART-1 in S, X and Ka bands were crossing the lunar ionosphere completely during the occultations of SMART-1, then spiralling along decreasing orbits around the Moon.
We thus achieved a host of data about the intensity, phase and polarization of the incoming waves that had just crossed the lunar ionosphere. Later data reductions are expected to provide us with the refraction index and the radial decreasing electron density of the tiny lunar ionosphere, that may also change according to the position of the Moon with respect to the Sun and the magnetic tail of the Earth. A good model of the lunar ionosphere and lunar signal attenuation would then hopefully emerge.
These measurements are important to understand the physics of the lunar atmosphere and also for radio frequency astronomical observations from the future lunar-based stations. Because of the increasing RFIs on the Earth, the future of (mainly) low frequency radio astronomy will be space-based and Moon-based, as described in detail by one of the authors, [1] and [2].