Distortions of the Low Frequency Signal by Martian Ionosphere at Vertical Propagation

O. N. Rzhiga

Institute of Radio Engineering and Electronics, Russian Academy of Sciences, Moscow, Russia (rzhiga@cplire.ru / Fax: (+7495) 203-8414)

At subsurface sounding the radar system of an orbiting spacecraft emits a radar signal to the planet's surface, which is then reflected and received by the system. The signal traverses the ionosphere that consists of electronically charged particles, which distort the signal.

A mathematical tool is described that takes into account signal distortions caused by phase dispersion and signal absorption in the Mars ionosphere during reflection from the Mars surface below the orbiter. This tool is used to estimate the distortion of the cross-correlation function (reducing the resolution of the radar measurement) by phase dispersion and signal absorption caused during a double traverse of the radio signal through the Mars nighttime ionosphere on frequencies used for the conducted now radar experiment MARSIS on-board the European Space Agency's Mars Express spacecraft.

Refractive and absorbing properties of an ionosphere are determined by free electron number density and collision frequency of the charged particles with neutral molecules. Two groups of the data are considered, distinguished by free electron number density in its lower part.

The absorption of a signal at a carrier frequency of 1.9 MHz (the lowest frequency of the radar system MARSIS) can reach 10–45 dB after double passage through the Martian ionosphere. Such uncertainty of absorption is defined by free electron number density in lower part of Martian ionosphere for the chosen models. In case of upper limit the ionospheric absorption can make virtually impossible detection of the weak signal reflected by Mars subsurface structures.

It is shown, that as it is unexpected, the account of absorption reduces distortion of the cross-correlation functions. This effect, probably, is connected to reduction of an effective frequency band of the received signal.