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Mars Subsurface Exploration Using Schumann Resonance

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In a planetary environment, an electrically conductive ionosphere and ground create a spherical electromagnetic cavity. In this cavity, extremely low frequency (ELF, 3-3000 Hz) electromagnetic waves are weakly attenuated and can propagate around the globe producing global resonance. The extremely low frequency waves are generated by electrical discharges in planetary atmospheres.

We have developed an analytical method that enables taking into account not only the electrical properties of the Martian ionosphere but also the Martian ground. This method allowed us to obtain the Schumann resonance frequencies and Q factors and analyze how they depend on the Martian environmental properties. We compared the results from our analytical model with previously published results from numerical modeling. In this work, we show that the Martian ground has a significant influence on the Schumann resonance parameters. Therefore, Schumann resonance can be used us a tool to study, not only the properties of the Martian atmosphere, but also the properties of the subsurface layers. It can be particularly useful in groundwater exploration.

In order to study the influence of water on the Schumann resonance parameters on Mars, we assumed two cases of the Martian ground containing aquifers. In both cases, we considered the upper part of the Martian crust composed of porous basaltic rocks containing ice. Beneath this layer, we implemented water-bearing basalts. We assumed that ice and water contains some NaCl impurities or solutions.

In the first case, we considered the low concentration of salts in ice and low-salinity water. In the second case, we assumed some high-impurity ice and brines. In order to compare the results of the above-mentioned cases with a situation in which the subsurface of Mars does not contain any water, we introduced the model of the Martian crust composed only of dry basaltic rocks.

There are clear differences in the Schumann resonance parameters for the different cases of the Martian ground. The Schumann resonance frequencies are higher by about 15% in the cases with aquifers compared to the pure basaltic ground. The amplitudes of Schumann resonance are also higher by about 40%. For all the analyzed cases, we have calculated and presented the spectra of the Schumann resonance.

Our new method used to obtain the Schumann resonance parameters on Mars can be applied also to other objects in the Solar System.

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