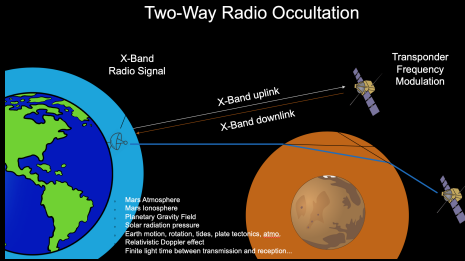


# Mars Radio Occultation



## SUMMARY.

Sounding planetary atmospheres in radio wave wavelengths is a powerful remote sensing method to investigate the atmospheric composition, structure as well as dynamics. As an electromagnetic wave propagates through a refractive medium, the signal experiences a phase variation corresponding to the integral of the index of refraction along the signal raypath. This physical effect provides a powerful mechanism for probing planetary atmospheres. A large fraction of our basic knowledge of the Mars atmospheres has been achieved from Radio Occultation (RO)

experiments flying on Mars orbiting spacecraft. The RO technique based on precise measurement of the Doppler shift observed on the link between a planetary spacecraft and Earth, as the spacecraft passes into occultation behind the planet, has been implemented on almost any spacecraft mission to Mars.

## OBJECTIVES

- Study the radio wave propagation through a refractive medium.
- Mars Orbiter data analysis
- Understand the principle dynamics and variability of Mars atmosphere and Ionosphere.

## PREREQUISITES

Dynamics and Planetology

## THEORY

by OZGUR KARATEKIN

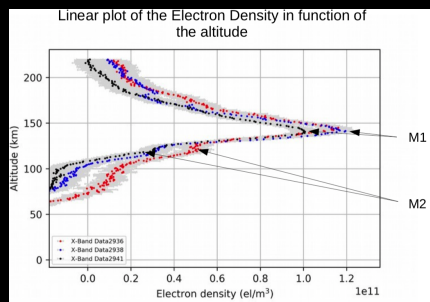
Radio wave propagation, Planetary atmosphere, Ionosphere

## APPLICATIONS

by OZGUR KARATEKIN

Radio wave propagation through a refractive medium, yields a variation in the signal phase corresponding to the integral of the index of refraction along the signal ray path. The associated phase delays lead to a frequency shift of the radio carrier signal. Hence, the radio waves do not propagate straight but

they are bent. The physical effects provide the measurement principles of RO to study planetary atmospheres with radio signals.



The RO technique has provided unique and valuable observations of the Martian atmosphere and ionosphere over the past 50 years. For instance ESA's Mars Express and TGO a transmit signals at both S-band and X-band. Changes in the radio signals while going through the atmosphere yield information on the refractivity, temperature pressure, and density of the neutral atmosphere, as well as the electron density in the ionosphere. So far more than 1000 RO have been performed.

## MAIN PROGRESSION STEPS

- First half of the period : Theoretical background & Bibliographic study.
- Second half of the period : Data Analysis.
- Last week : preparation of the final oral presentation.

## EVALUATION

- The evaluation will be based on the project.
- Understanding of the background (30%), data analysis (40%), interpretation of the results (30%)

## BIBLIOGRAPHY & RESSOURCES

MEX Orbiter Radio Science Karatekin et al. 2019

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