Multi-wavelength 3D mapping of the atmospheric circulation of Venus using Venus Express and ground-based observations

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Abstract: Venus and the Earth are considered to be the twin planets of the Solar System: both formed in the same region of the solar nebula and reached the end of the planetary accretion stage with very similar masses and compositions. Venus and the Earth, however, followed very different evolutionary paths. Their atmospheres, in particular, display striking contrasts in thermal structures, compositions and circulation mechanisms. Venus is covered with a thick layer of clouds, which is optically thick in the visible and prevents direct observation of the surface. These clouds are formed by H2SO4 droplets and reflect most of the incoming solar radiation back to space. The atmosphere is characterized by rapid circulation, the so-called superrotation, seen in fast cloud motions at ultraviolet, visible and near and thermal infrared wavelengths. The mechanisms at the origin of superrotation, however, and the atmospheric circulation and variability between 75 and 100 km altitude remain largely unknown, due to a lack of adequate techniques for measuring winds in that region. Moreover, the recent detection of long-term variations in the amount of atmospheric SO2, a crucial trace component of the atmosphere, led to the hypothesis that atmospheric oscillations similar to terrestrial phenomena may occur on Venus. The causes of such variations, which may be related with active volcanism at the surface, remain to be understood.

In this project the student will utilize observations made during the last 6 years by the Venus Express spacecraft, currently orbiting Venus, with the objective of measuring the winds in the Venus mesosphere. This work will be based on the techniques of Doppler velocimetry and cloud tracking developed by the planetary atmospheres group at CAAUL. High-resolution infrared spectroscopy data from Venus Express, together with ground-based observations from the VLT (Chile) and CFHT (Hawaii), will be analyzed in order to directly measure Venus winds between 70 and 100 km altitude and to characterize atmospheric superrotation, detect wave phenomena and monitor long-term variability of the atmospheric dynamics. A full characterization of this region of the atmosphere is crucial for understanding the behavior of terrestrial-type exoplanets in the habitable zone and to design and prepare for future missions to Venus.

The planetary atmospheres group of CAAUL collaborates with a large number of international teams in space sciences. The selected candidate is expected to be proficient in written and spoken English, have excellent communication skills and availability to travel. Short stays in collaborating research centers in Europe may be necessary. Applications to PhD theses in association with other European universities or to European PhD theses are encouraged. Candidates will have support from CAAUL for applying to research studentships.