COST ACTION MP1104: Short Term Scientific Mission Report

"Going further into modeling of the polarization of Venus"

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Objectives:

As subject of my PhD thesis, I study Venus cloud layers with polarimetric data from the spectrometer SPICAV-IR on-board ESA's Venus Express spacecraft. After a first contact in EGU 2013, we decided with Daphne Stam, Frans Snik and Michiel Rodenhuis, to have a first STSM with the COST action MP1104. The aim was to learn to use the radiative transfer code with polarization used by Daphne Stam. This led to the application of this code to the modeling of Venus clouds. A publication has been submitted to Planetary and Space Science in a special issue on Venus exploration[1]. After ASTROPOL 2014 we decided to apply for a new STSM in order to go further in our collaboration.

1. To improve the modeling of Venus clouds with the radiative transfer code with polarization;
2. To address some possible geometric issues in SPICAV-IR observations;
3. To address the polarimetric data gathered from the ground by M. Rodenhuis with the ExPo/IFU instrument.

Radiative transfer code:

With the help of Daphne we improved the model by reducing computing time, which will be significant when dealing with all of SPICAV-IR data set (6 years of observations). We also managed to couple the Fortran routines from the radiative transfer code with Python, which I use for the observations. The comparison of models with data is hence easier and the code runs faster. The code was also improved as it generates one output file for one set of input parameters. This file contains expansion coefficients for selected geometries (supermatrices). Then, the intermediate geometries can be retrieved by interpolation. This is also a significant gain of time because we can apply the same model to different geometries: we only need to run the radiative transfer code once and then interpolate when necessary.

SPICAV-IR observations:

SPICAV-IR performs observations in different geometries: nadir observations with low emission angles and phase angle being strongly correlated with solar zenith angle, yielding latitudinal scans; and "spot-tracking" observations where the emission angle can vary in a wider range allowing observation of one location at different phase angle. In spot-tracking observations, the curves exhibit an unexpected behavior. From geometric analysis it appears that the field of view of SPICAV is quite big (2°), enough for part of it to be outside of the the planet in slanted observations. As the polarization is integrated on the FOV, the degree of linear polarization measured could be different of the real value.

1 Rossi et al., Preliminary study of Venus cloud layers with polarimetric data from SPICAV/VEx, Planetary and Space Science, 2014 (submitted)

The geometrical possibilities offered by the new version of the model will allow us to simulate this effect.
We also discussed the possibility of retrieving the cloud-top altitude with the polarization within absorption bands (for SPICAV-IR, the CO_2 band around 1.4 μm).

Ground-based observations:
M. Rodenhuis has performed observations of Venus with the Extreme Polarimeter (ExPo). These observations are complementary to those by SPICAV as they offer a wider latitudinal coverage, although they have a lesser phase angle coverage. They also cover smaller wavelengths than those of SPICAV. The new version of the code will allow us to consider a single model and to test it on the different geometries for both SPICAV and ExPo. Hence comparison will be possible and we will try to find a model that is consistent with both data set.

Conclusion:
With this new version, I hope to get soon maps of parameters out of SPICAV-IR polarimetric measurements, allowing comparison with other Venus Express instruments such as VMC, which is measuring photometric phase functions.
I acknowledge the support of the COST action MP1104 for allowing this STSM and the previous one, which were very important for my PhD thesis. I intend to pursue the collaboration with D. Stam, F. Snik and M. Rodenhuis on polarimetric observations of Venus, in particular with potential publications. I thank D. Stam, F. Snik and M. Rodenhuis for hosting me and for their precious help and suggestions.