COST
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

Polarisation as a tool to study the Solar System and beyond
Action MP1104

STSM Scientific Report Template

Applicant and home institution : Will McLean, Armagh Observatory, UK

Visited scientist and host institution : Dr Daphne Stam, TU Delft, Netherlands

Dates of STSM : 22/06/15 - 26/06/15

Explain briefly below how your STSM matched one of these key-points :

1. strengthen current collaborative projects
2. establish new collaborations
3. obtain necessary knowledge for the application of new techniques
4. use host infrastructures that are not available at the home institute.

The purpose of this Short-Term-Scientific-Mission to TU Delft was to work with Dr Daphne Stam's radiative transfer code, and use it to model the polarisation of light reflected by the atmospheres of the outer planets and moons of the Solar System. A previous STSM also involved visiting Dr Stam and working with her code, where both the numerical modelling and the geometrical aspects of the code were explained. The latest STSM involved working on further modifications of the code, such as modelling the signature of spectral lines in atmospheres, and adding different layers of cloud and haze particles with varying properties. The main project to emerge from this STSM is the modelling of recent polarimetric observations of Jupiter, which will be published in a journal in the coming months.

Describe below the activities carried out during the STSM and the main results obtained.

The application of Dr Stam's code for my PhD project is for the modelling of recently obtained observations of planets and moons of the outer Solar System. Polarimetry is a valuable tool for probing the atmospheres of these bodies, and in order to interpret the observations, numerical models are required.

The models are ran with varying cloud and haze particle properties, most importantly the size distribution and the refractive indices. In addition, the amount of each type of particle in different layers of the atmosphere can be varied, and in this way the results from the observations can be fitted with a model containing different types of particle at different points on the planet, e.g. for Jupiter, a different type of haze at the poles from the equatorial belts can be a potential reason for a change in polarisation between the two regions - and this is shown through the modelling. In order to model the variation of polarisation across the planets, the code which integrates the scattering coefficients across the planetary disk had to be modified, in order to produce an output for each pixel, which has a different angle of incidence and reflection of the incident solar radiation. This was implemented in the code, and the models can now be ran with different inputs for each pixel, to generate a realistic model of an inhomogeneous planet such as Jupiter.

The first application of the code will be to the modelling of recently obtained broadband polarimetric maps of Jupiter, in three filters, which will lead to a journal publication sometime in the next few months. After this, modelling of the other outer planets will be carried out, and also of several moons of these planets. In addition to investigating the properties of planets in the Solar System, this work has an important application to exoplanet science, since when future polarimetric observations of exoplanets become available, numerical models will be required to interpret them.