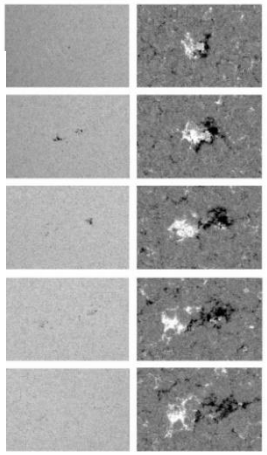
Temporal evolution

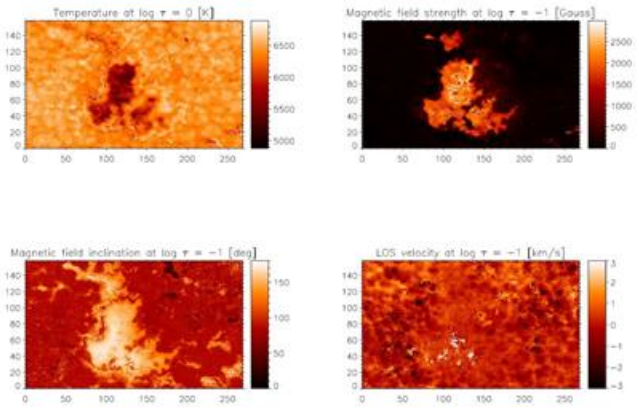


The short lived active region NOAA12549 was formed on the 27th of May and it completely disappeared on the 31th of May 2016.

The entire five-days evolution is followed using continuum images and magnetograms from HMI/SDO, as shown in the mosaic to the side. In the first column an image in the continuum for each day is reported; in the second column the contemporary magnetograms are reported.

The result of the inversions

The inversions are made using a code developed by the writer that calls the SIR code pixel by pixel in the scanned region, starting from two different models (umbra and quiet Sun) and choosing the best one with a merit function. With the inversions we are able to obtain the maps of the physical quantities of the solar atmosphere (temperature, magnetic field strength, magnetic field inclination and LOS velocity).

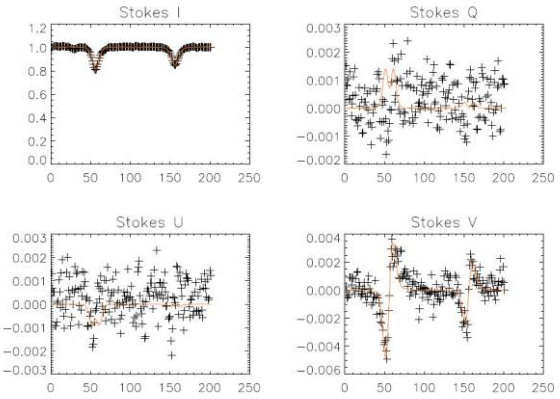


Discussion

- A contour of higher temperature is observed along the entire perimeter of the pore.

- Moving magnetic features (MMFs) are observed during the decay phase of the active region.

- The inversions indicate the presence of strong motions of downflow (figure below):



Conclusions

A set of spectro-polarimetric data acquired during an observing campaign carried out at the GREGOR solar telescope has been analyzed. In order to perform this analysis, an IDL code, named MESISP, has been developed with the aim of obtaining the synthesis and the inversion of the Stokes profiles in the Milne-Eddington approximation.

However, in order to obtain indications on the stratification of the physical parameters (temperature, magnetic field strength, magnetic field inclination and line-of-sight velocity) in the solar atmosphere, the real inversion of the dataset has been carried out using the SIR code.

The results obtained indicate the presence of a contour of higher temperature around the pores, which interestingly did not develop a penumbra. Furthermore, MMFs and strong downflows were observed in the analyzed regions. Some instrumental issues, like the presence of stray light, could be evidenced during the analysis of the Stokes profiles.

UNIVERSITA' DEGLI STUDI DI CATANIA

DIPARTIMENTO DI FISICA E ASTRONOMIA

CORSO DI LAUREA MAGISTRALE IN FISICA

GIORGIO VIAVATTENE

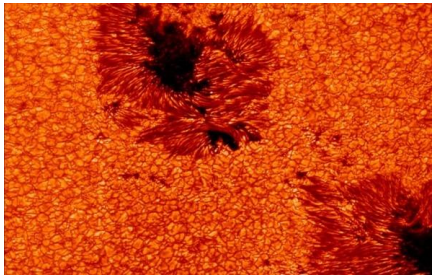
Spectro-polarimetric analysis of a short lived solar active region

Supervisor: Professor Francesca Zuccarello

Co-supervisor: Manolo Collados Vera

Co-supervisor: Basilio Ruiz Cobo

Training abroad at the ***Instituto de Astrofisica de Canarias***



Introduction

Magnetic fields play a crucial role in the formation and evolution of solar active regions. Despite the progress achieved in the comprehension of many solar phenomena, due to both ground-based and satellite observations, the processes of formation, evolution and disappearance of the active regions have some aspects that are not yet completely clear.

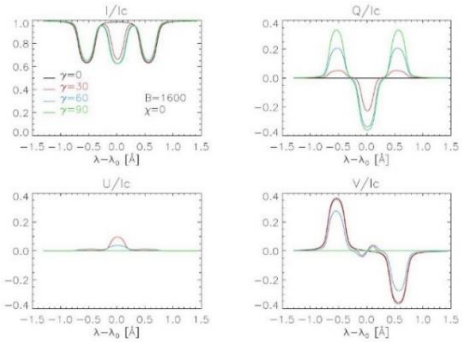
In this context, the purpose of this thesis is to study the magnetic and the thermodynamic properties of a short lived solar active region using high resolution spectro-polarimetric data.

The thesis was carried out spending three months at the *Instituto de Astrofisica de Canarias.*

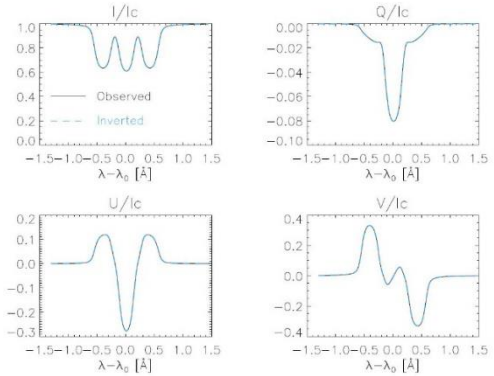
MESISP code

The Stokes profiles of lines emitted in the solar atmosphere provide information on the polarization of light at different wavelengths. The use of inversion codes allows to obtain information on the emitting plasma starting from the observed Stokes profiles.

The MESISP (Milne-Eddington Synthesis and Inversion of Stokes Profiles) code was developed during the thesis period and it is an IDL code that performs the synthesis and the inversion of the Stokes Profiles using the Milne-Eddington approximation. Here an example of synthesis (Stokes profiles at different inclination of the magnetic field vector):



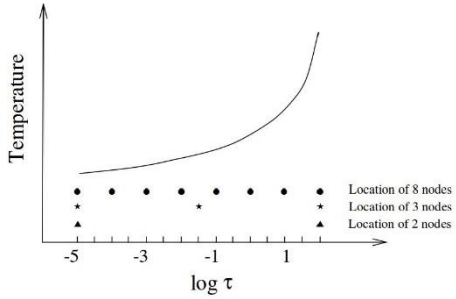
Here an example of inversion using the Levenberg-Marquardt algorithm in order to retrieve the physical parameters (magnetic field vector, temperature, source function, shape and position of the line) of the plasma in the solar atmosphere:



SIR code

The SIR (Stokes Inversion based on Response functions) code is more complex than the MESISP code and it takes into account also the macroturbolence velocity, the stray light, the weight of the Stokes Profiles, the heliocentric angle.

The SIR code is also able to provide a ***stratification of the physical parameters*** along the solar atmosphere, using the concept of *nodes*.

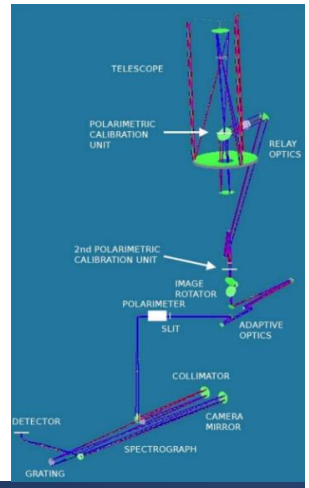


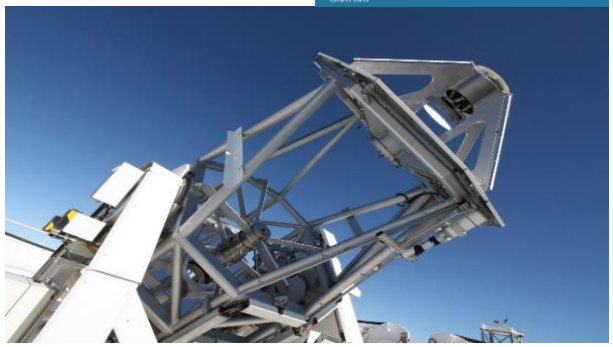
The GREGOR solar telescope

The GREGOR is the biggest solar telescope in Europe, with a diameter of 1.5 meters.

With the adaptive optics it reaches the resolution of 0,13'', corresponding to 80 km on the solar surface.

The data are acquired with the GRIS instrument, a grating infrared spectrograph.





The target

During the observing campaign at the GREGOR telescope, three scans of the active region NOAA12549 were acquired, in order to study its magnetic and thermodynamic properties. The images below show the target at different wavelengths.

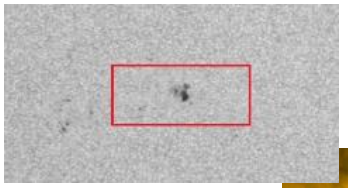


Image from HMI/SDO in the visible wavelengths (photosphere)

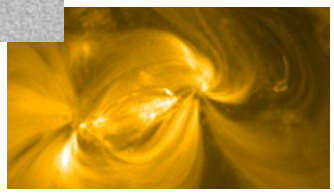


Image from AIA/SDO in the EVU (corona)