Spectropolarimetic study of dust and magnetic fields in Nearby Galaxies

Overview: We are offering a Masters project at the SAAO to work on the analysis of SALT spectropolarimetry data of nearby galaxies to probe the source of optical polarisation emanating from them. This will pave the way to test physics of dust and magnetic fields in other galaxies, which has not yet been done through optical polarimetry.

Supervisor

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Context & Motivation

Disk or spiral galaxies are known to be filled with dust, molecules, and free electrons, which serve as scattering agents for the light produced by the stars. When observing a disk galaxy in optical wavelengths, a substantial fraction of the light will be scattered off of these agents. Scattered light, by its nature, can be highly polarised orthogonal to the plane of scattering. Scattering is not the only process that can produce polarised light. Galaxies are permeated by magnetic fields which can align dust grains preferentially perpendicular to the magnetic field lines. In optical wavelengths, dust grains absorb the component of light which is polarised along their major axis, resulting in the remaining light appearing polarised in the perpendicular direction, parallel to magnetic field lines. This referred to as dichroism, and is used to trace the magnetic field direction. These two processes compete with each other, and this is imprinted in the obtained spectropolarimetry data from the source.

While there is a solid theoretical background that supports the scenario that the polarisation of the light of galaxies can be preferentially either parallel or perpendicular to the major axis, the global picture seems to be more complex. Previous works measured the polarisation of the integrated light of spiral galaxies in the B band filter and found that more than half of their sample does not follow the expected trend. Since the physics of scattering is fairly well-studied and understood, this result may imply that magnetic fields do not necessarily behave as we expect, i.e. they do not always follow the galactic disk. In fact, near and far-infrared polarimetric observations of resolved galactic disks reveal that polarisation patterns (and, thus, magnetic field lines) can be complicated, different in different parts of the galaxy and, in general, not what it was originally believed.

Thus, we still don't fully understand how optical polarisation is produced in nearby galaxies, and the basic assumption that the polarisation angle is always parallel or perpendicular to the major axis of the galaxy is not sufficiently backed by observational data. Long-slit spectropolarimetry will be a game changer in this regards, since it will unveil the wavelength and spatial variations of polarisation within the galaxy, and will offer a unique opportunity to disentangle and model the contributions of scattering and dichroism. Therefore, not only will it offer information on the relationship between polarisation angle and galaxy orientation, but it will also provide insights about the physics of dust and magnetic fields in galaxies.

To pursue the above questions, we have an ongoing long term SALT program which will provide large amounts of RSS long-slit spectropolarimetry data. For the observations, we have selected a sample of galaxies with different morphological types and nuclear activity to have a global picture of how polarisation behaves in different environments, since this is a completely unexplored field.

Project Details

The Masters project will consist of working on the reduction of data from SALT and resultant publications. The student will work closely with Dr. Maharana, and his collaborators Prof. Kostas Tassis and PhD student Mr. Niko Mandarakas at the University of Crete, Greece. Further, through Dr. Maharana, the student will have the option of applying for time on the RoboPol polarimeter in Crete to obtain additional data as per the work requirements.

Required Skillsets:

While there is no strict prerequisite skillset needed for the project, during the course of the work, the student will need to spend a substantial amount of their time in reducing the data obtained from SALT and other telescopes. Although no prior programming knowledge is needed, it is expected that the student will need to learn it during the course of the project depending on the requirements.

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