List of ITA summer projects, 2024

1. Detection and classification of Ellerman Bombs in Solar observations using Deep Learning (2 positions)
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Detection and classification of Ellerman Bombs in Solar observations using Deep Learning

Supervisors:

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Magne Elias Roland Udnæs, e.r.udnas@astro.uio.no

Project Description

Ellerman Bombs are highly energetic transient events that occur continuously in the solar lower atmosphere. They are products of a phenomenon called magnetic reconnection, in which the magnetic field lines change their topology, causing an enormous release of energy.

Ellerman Bombs occur mainly in the Active Regions, fields of the Sun characterized by the emergence of strong magnetic fields of a couple of thousands of Gauss. Thus, the study of Ellerman Bombs properties may provide us with new insights into the evolution of magnetic field in Active Regions, the reconnection process, and the mechanisms of chromospheric heating.

With the development of Deep Learning techniques, we are able, for the first time, to detect Ellerman Bombs automatically in many unseen observations. For this, we have developed and trained a neural network. Now, it is time to use it and start detecting Ellerman Bombs and extracting new knowledge from them by applying statistical studies to large numbers of detections.

The role of the student will be first to learn how to use the developed Neural Network and how to deal and apply it to large solar observations. Once we are able to detect correctly, we will do a statistical analysis and study of all the detections. This will allow us to establish new constraints and modes on the occurrence of Ellerman Bombs.

With this project, the student is aimed to go deeper into the field of solar physics. In terms of methods, the student will learn to analyze and work with high-resolution solar observations, to apply Deep Learning techniques to the data, use version control (git), and to work in a scientific environment.

Position Qualifications

- Last semester of bachelor.
- This project is suitable for anyone interested in learning more about the Sun and Solar physics, Deep Learning and big data/observations management. Coding will take an important role in this project, so we will prioritize students with coding skills in Python.
- The project is highly recommended for students interested in taking a master in Solar physics.
- Project duration: 5-6 weeks. Supervision is possible during June, July, and August.

Analysis of solar surface simulations & comparison with observations

Supervisor:

Quentin NORAZ, RoCS/WholeSun Post-doctoral Researcher, q.j.f.a.noraz@astro.uio.no

Project Description

The Sun rotates and its surface is covered by convective motions, which generate a dynamo process, at the origin of a solar magnetic field. This field can either be large-scale, such as sunspots (active regions), or usually at smaller scales and spread over most of the surface, then called quiet Sun regions. If the large-scale magnetic field is known to vary in space and time, quiet Sun magnetism has long seemed relatively stationary, uniform and independent. However, new observations seem to reveal that it could also vary, and is currently the subject of active research. This is done in part with numerical simulations of the solar surface, by using the Bifrost code, developed here at RoCS.

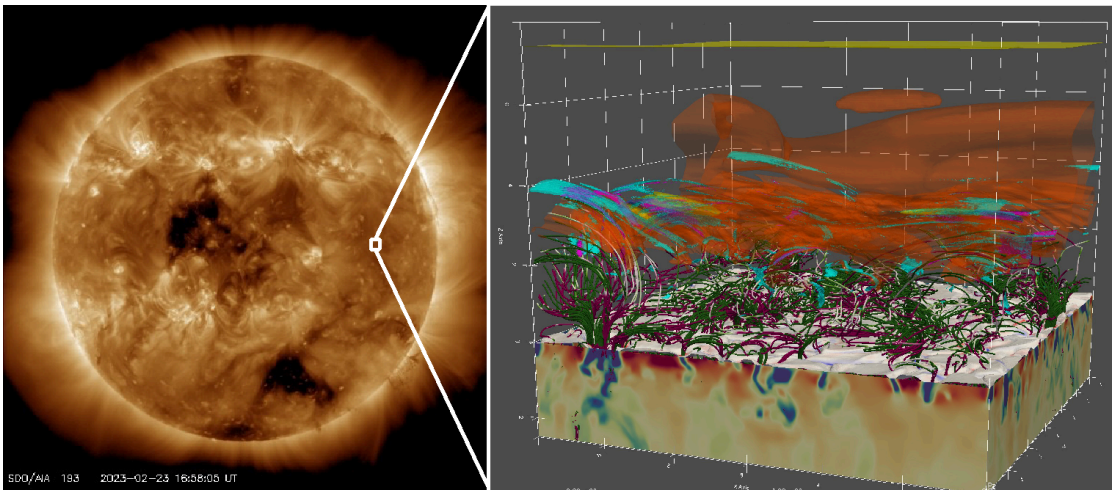

Figure 1: Comparison of UV solar observations (left) with Bifrost simulations (right). The 3D visualization shows the simulated box surface (white) above deeper convection (red/blue for rising/sinking cells) and below the small-scale magnetic field, represented with green and purple lines rising into the atmosphere. Cyan and magenta surfaces highlight Ohmic and viscous dissipations, which increase the temperature, illustrated by orange and yellow surfaces at 10.000 and 100.000 K.

Your mission, should you decide to accept it, will be to help understand quiet Sun regions.

- For this, you will have at your disposal several 3D simulations of the quiet Sun, differentiated by the intensity of the magnetic field generated.
- Analyzing their dynamics and comparing it to current observations on the Sun will allow to better understand mysteries of the solar magnetism.
- You will gain practical skills in data analysis, comparative study, data visualization, as well as knowledge of solar physics and scientific criticism.

Position Qualifications

- A background with Python uses and fluid mechanics. Knowledge about MHD/solar physics and Fortran codes is preferable but not necessary.
- Suited for Bachelor and Master students.
- Duration: 5 weeks (to be discussed), spread during July and August. Depending on computing skills of the student, and her/his willing to go deeper in the analysis and understanding.

Cosmological data analysis in 3D

Supervisor:

Ingunn Kathrine Wehus, i.k.wehus@astro.uio.no

Project description

Are you interested in understanding how the Universe works? The CMB&CO group is looking for motivated students to help us build the next iteration of the course "AST9240 - Bayesian Cosmological Data Analysis", an advanced course in cosmology where students learn to use real-world data to disentangle the mysteries of the Cosmic Microwave Background.

This year, the course will revolve around expanding our data from 2D to 3D, meaning that in addition to data from conventional CMB experiments like WMAP and Planck, we will also be using data from line intensity mapping surveys such as COMAP. We are offering a six-week paid position during the summer of 2024, where the successful applicant will be developing a Jupyter notebook that will be part of the coursework for this course: You will be creating a simulated line intensity mapping experiment, which you will then use statistical sampling methods like MCMC and Gibbs sampling to analyse the simulated data and to finally estimate the cosmological parameters of the Universe.

This is a great opportunity for anyone who has an interest in cosmology and data analysis, and you will learn skills that will be useful in your future career, whether that is in academia or the industry. You'll be working alongside PhDs and postdocs in the CMB&CO group in an exciting scientific environment.

Position Qualifications

- You should like to program, and be comfortable with Python programming.
- Project duration: 6 weeks

Utvikling av numeriske prosjektoppgaver til nytt kurs om stjerneutvikling

Veileder:

Øystein Elgarøy, oystein.elgaroy@astro.uio.no

Prosjektbeskrivelse

Institutt for teoretisk astrofysikk skal utvikle et nytt emne om stjerneutvikling for studenter i 4. semester på FA-programmet. Siden arbeidet startet nylig, er ikke detaljene på plass ennå, men temaer som vil bli dekket er stjernedannelse, de ulike stadiene i stjernenes liv, supernova-eksplosjoner, og strukturen til hvite dverger og nøytronstjerner.

Prosjektet består i å hjelpe til med å utvikle numeriske oppgaver til kurset. Eksamen i kurset vil bestå av tre hjemmeeksamener der hovedvekten vil ligge på numeriske beregninger, og det er spesielt disse vi ønsker hjelp til å lage og teste. Vi ser etter to studenter som kan jobbe sammen med dette i fire uker.

Krav til søker

- Siste semester på FA-programmet eller masterstudent.
- Dette prosjektet passer for alle som er interessert i å lære om stjerneutvikling og liker Python-programmering.
- Prosjektet varer i fire uker.
- Veileder er tilgjengelig i slutten av juni og i hele august.