Stellar Coronagraphy for Exoplanets Detection

SUMMARY.
In this METEOR, the student will participate in the development of a new type of stellar coronagraph (PLACID, developed in Switzerland) whose focal plane mask is based on a programmable liquid crystal array, able to find companions around binaries or more complex structures. The project will take place in Switzerland, at the University of Applied Sciences Western Switzerland in Yverdon-les-Bains (HEIG-VD) and with the Center for Space Habitability of the University of Bern (UBE). The internship will consist in working with the team to explore the limits of this novel technique, via modelling and laboratory testing.

— OBJECTIVES

- Learning to work with an engineering and science team in the context of an astronomical instrument development. The student will learn about optics, optics laboratory and optical system modelling, all in collaboration and with the guidance of experts in the field of optics and instrumental astrophysics. The student will also have the opportunity to see how an instrument project is managed.

- From the many exchanges with the coronagraph development team, the student will be able to gain independence and maturity in the development of a research program, by being able to make use of existing academic knowledge and other peoples' skills.

— INSTITUTE

Optical Research and Development Laboratory (OptoLab), Department of Industrial Technologies, University of Applied Sciences Western Switzerland, HEIG-VD, Rte de Cheseaux, 1, CH-1401 Yverdon-les-Bains, Switzerland.

— THEORY

by Prof. L. Jolissaint

In this METEOR, theory will be in the domain of optical propagation, and the other topics that will be convered will be:

- Fourier optics
- Numerical methods (coding in IDL or Python)
- Signal/image processing

— APPLICATIONS

by Prof. L. Jolissaint

Beyond working in the PLACID coronagraph model, the student will also continue the development of an earlier research that was started by a previous METEOR group: a deep analysis of the impact of optimal turbulence and noise on the images of a stellar object, from the simplest case of a seeing limited observation to the most complex case, i.e. an adaptive optics fed coronagraph. Thanks to these first simulations, our group has been able to understand better the need for AO in the context of a coronagraph, but there is still much to do to push the analysis further. At the end, this understanding will be used in the development of the DAG coronagraph reduction software, so this research is critical for the success of PLACID observations.

— MAIN PROGRESSION STEPS

- getting to understand about coronagraphs and extreme adaptive optics, by discussions with the team and literature study; understanding previous METEOR work and results;

- continue to push forward the research on coronagraph limitations; simulating PLACID and laboratory verifications;

- Documenting the results, preparing for an oral presentation.

— EVALUATION

The evaluation will be done via an oral presentation (50%) and the project's results report (50%).

— BIBLIOGRAPHY & RESOURCES

Active focal-plane coronagraphy with liquid-crystal spatial-light modulators: broadband contrast performance in the visible, Applied Optics, vol. 61, issue 30, p. 9000, October 2022.

An introduction to stellar coronagraphy, Introduction à la coronographie stellaire, A. Ferrari, R. Soummer, C. Aime; Comptes Rendus Physique, vol. 8, issue 3-4, April-May 2007, p. 277-287

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