

PROPOSITION DE SUJET DE THESE

Intitulé : Interferometric imaging based on photonic integrated circuits / Imagerie interférométrique à base de circuits photoniques intégrés

Référence : **PHY-DOTA-2024-16**
(à rappeler dans toute correspondance)

Début de la thèse : Octobre 2024

Date limite de candidature : Mai 2024

Mots clés :

Interferometric imaging, integrated optics, waveguides, image reconstruction.

(VF : Imagerie interférométrique, Optique intégrée, guides d'ondes, reconstruction d'images)

Profil et compétences recherchées :

Physical optics, image processing, programming (Python, Matlab...). Keen interest in optical experimentation and data processing.

(VF : Optique physique, traitement d'images, programmation (Python, Matlab...). Goût prononcé pour l'expérimentation optique et le traitement de données)

Présentation du projet doctoral, contexte et objectif :

Contexte:

A concept for an optical interferometric imager was proposed by Lockheed-Martin in the early 2010s. In this concept, the aperture is paved with lenses. The optical signals collected by these lenses are combined in photonic integrated circuits, enabling simultaneous measurement of the Fourier components of the observed object at several spatial frequencies - known as visibilities. This concept makes it possible to significantly reduce the size of optical telescopes, for example for Earth observation. Indeed, the transverse dimension of a device based on this concept remains close to that of a telescope of the same resolution, since the transverse size determines the spatial resolution. On the other hand, its size along the optical axis is much smaller than that of a conventional telescope. Several teams are working on the development of such a concept, notably in the USA and in China. Partial experimental demonstrations have been carried out with planar photonic circuits associated with lines of lenses. At ONERA, the theoretical analysis of this concept was carried out as part of a thesis which has recently been completed.

In the short term, the implementation of this concept proves tricky, both because of the complexity of the photonic circuit - the number of lenses being of the same order of magnitude as the number of sought resolution elements - and because of the instrumental constraints associated with interferometric measurement.

The proposed thesis focuses on the reduction of the complexity of such a concept by combining a low-resolution image formed with a small telescope with visibilities measured at high spatial frequencies (hybrid instrument). It will be carried out in collaboration with astronomers who are developing instruments based on optical interferometry for astrometry and high contrast imaging. The first part of the thesis will be devoted to the development of an algorithm dedicated to high-resolution image reconstruction with these data via a co-design approach and then to its test by numerical simulations. A laboratory experiment will be carried out in the second part of the thesis. Its objective will be to test this concept (measurement of a low-resolution image and visibilities then image reconstruction) and to evaluate the limitations to its experimental implementation. Visibility measurements will be carried out in particular with a planar photonic circuit built using the know-how developed by astronomers in the field. As a planar photonic circuit only allows the measurement of a few visibilities, this work could be complemented by the definition of a three-dimensional photonic circuit allowing access to the simultaneous measurement of a higher number of visibilities, compatible with the reconstruction of a complex image. The PhD student will benefit from the skills in optical instrumentation, the characterization resources and the know-how of the Department of Optics and Associated Techniques at ONERA.

Collaborations envisagées :

Observatoire de Paris, partenaire industriel (ADS ou TAS)

Laboratoire d'accueil à l'ONERA :

Département : Optique et Techniques Associées

Lieu (centre ONERA) : Châtillon

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Pour plus d'informations : <https://www.onera.fr/rejoindre-onera/la-formation-par-la-recherche>