



**PhD course of National Interest in Technologies for  
Fundamental Research in Physics and Astrophysics**

## Annual report

**Name and surname: Gupta Dhiraj Hiralal**

**Cycle and a.a.: 39<sup>o</sup> cycle 2023/2024**

**Supervisor: Dr. Andrea Bianco**

- **Research activity carried out during the year**

Research Topic: Innovative Holographic Optical Elements for Modern Optical Instrumentation  
The research focuses on developing Volume Holographic Optical Elements (VHOEs) to enhance and simplify optical systems used in astronomical instrumentation, spectroscopy, and adaptive optics. The primary objective is the design and application of Volume Phase Holographic Gratings (VPHGs) and Holographic Diffusers.

1. Theoretical work:

I conducted a review of papers to understand the principles of holographic gratings and diffusers and their main applications.

2. Definition of the requirements and development of a Model for Holographic Diffusers: in collaboration with the INAF institute in Bologna, the requirements of a diffuser for the modulation of a pyramid wavefront sensor were defined and I've started the development of a model for the holographic diffuser suitable for this application.

3. Laser Setup and Fabrication: in the meantime, I've set up a holographic system for writing VHOEs based on a green laser. This activity allowed me to develop competences in optics. With this system, I've written VPHGs with different features (i.e. line density, diffraction efficiency) and I characterized them.

4. Activities at telescopes: I had the opportunity to work at the Asiago Copernico telescope for testing a dispersing element based on VPHGs. Moreover, I spent a period at the TNG in La Palma working on the increase of the GIANO (an infrared echelle spectrograph) performances by improving pre-slit sensitivity and ensuring accurate slit alignment. This is an ongoing activity.

5 Achievements:

- Built Laser setup
- Understood the installation process of VPHGs at the ASIAGO Telescope.
- GIANO pre-slit Spectrometer: Contributed to enhancing the GIANO infrared echelle spectrometer at the TNG Telescope.

6. Challenges and Solutions:

- Fabrication Challenges: Experienced difficulties with laser setup and fabrication conditions. Resolved these through detailed training and iterative adjustments.
- Modelling Challenge: Facing challenges in adapting HOE models for diffusers.

7. Ongoing Work:



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Continuing to develop the model for holographic diffusers based on the study of HOEs, with a focus on improving light scattering characteristics and performance and making use of the laser setup for holographic diffusers.

- **List of attended courses and passed exams**

1. Adaptive Optics for Astronomy
2. Radio and Optical Interferometry
3. Laser Physics and Applications

- **List of attended conferences, workshops and schools, with mention of the presented talks**

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- **List of published papers/proceedings**

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- **Thesis title**

**“Innovative holographic optical elements for modern optical instrumentation”**

Date, 09/09/2024

Signature

Seen, the supervisor