Mechanisms of Visible Emission in Novel Fluoride Glasses and Fibers

Stage M1 (M2) in Material Science, Physics and Optics

Host laboratory: **Centre de Recherche sur les Ions, les Matériaux et la Photonique** (CIMAP), UMR 6252 CNRS-CEA-ENSICAEN, Université de Caen Normandie, 6 Boulevard Maréchal Juin, 14050 Caen

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Duration: 4 to 6 months

Scientific context: There is a growing demand for compact and efficient visible lasers, directly excited in the blue, for applications in high-resolution microscopy, biomedicine, and quantum information. The CIMAP laboratory participates in the *LUMEN* project (*Lasers à fibre fluorée émettant dans le visible*), funded by BPI France, which unites academic and industrial partners in France to develop a new generation of multi-color visible lasers based on rare-earth-doped fluoride glass fibers. This internship aims to provide new insights into visible luminescence mechanisms of rare-earth ions (Sm^{3+}, Tb^{3+}, Dy^{3+}) embedded in fluoride glasses and fibers, with the goal of proposing innovative optical materials for visible lasers. The work will be carried out in close collaboration with *Oxxius* and *Le Verre Fluoré*, leaders in fluoride-based laser technologies. The applicant will focus on rare-earth doping mechanisms (including ion clustering), UV–visible excitation, luminescence quenching, energy-transfer processes, and photodarkening. A comparison with fluoride single crystals elaborated at CIMAP will also be performed. µ-spectroscopy will be used to probe the distribution of rare-earth ions within glass fibers.

Host laboratory: This project will develop at CIMAP, a research laboratory in Caen, Normandy. The team OML (Optics, Materials and Lasers, >20 persons including permanent staff, Post-Docs, PhD and Master students) is known for its excellence in developing novel functional optical materials. In the past years, the OML team has been leading research on fluoride materials and visible fiber lasers. The team is fully equipped with top-level apparatus for advanced optical characterization of glasses and crystals. The group is dynamic and international, with a strong publication record. In addition to supervision by a CNRS researcher, the candidate will be assisted by a research engineer responsible for structural characterizations, and a technician for polishing / shaping.

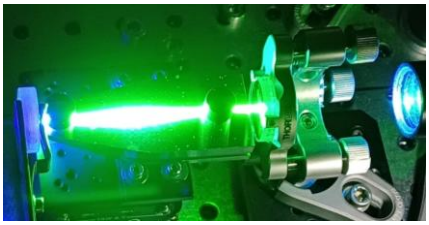

Figure: Green emission from a Holmium-doped fluoride fiber.

Details of the project: The applicant will undergo an integration period within the research team, gaining experience in best practices for handling optical materials in line with safety regulations. Immersion in the laboratory, alongside PhD students, will foster a research mindset and provide exposure to material elaboration and characterization facilities. The internship includes a literature review on visible emission from rare-earth-doped materials. For the study of crystals, involvement in crystal growth and characterization is possible. The internship will involve µ-Raman/luminescence spectroscopy on a dedicated microscope, as well as other advanced spectroscopy techniques such as UV-visible excitation, luminescence, time-resolved studies, cryogenic measurements, and FTIR. The candidate will be guided at all stages and trained to use various equipment. Scientific outcomes are expected in the form of conference contributions and/or journal publications.

Languages: French, English.

A ***PhD position*** could be offered following this internship.