**Internship offer**

**Topic of the internship (title)**  
*Pure-Quartic Solitons in Integrated active photonic crystal structures*

**Proposed dates of the internship**  
Start: 01/10/2023  
End: 31/03/2024

**Scientific and academic objectives of the internship:**

Optical solitons are wave packets that can propagate without changing shape\(^1\). These pulses have underpinned numerous applications, ranging from telecommunications and spectroscopy to ultrashort pulse generation. Conventionally, solitons rely on the balance between the Kerr nonlinearity and negative second-order dispersion (\(\beta_2 < 0\)) as it is the dominant dispersion effects in typical optical waveguides. The Usyd group has recently observed and generated a novel class of optical solitons, called pure-quartic soliton (PQS)\(^1, 2\). These arise from the interplay between Kerr nonlinearity and negative fourth-order dispersion (\(\beta_4 < 0\)), providing substantially higher pulse energy – by a few orders of magnitude, than conventional solitons, while offering the same coherence and stability.

This project aims to build on these recent discoveries, and to transfer this new physics of PQSs to integrated photonic platforms in the telecom band (~ 1.5 \(\mu\)m) that include an active gain medium. Planar III-V photonic crystals will be explored to that aim, as they allow for a fine control of the underlying photonic dispersion by simply adjusting the position of the air holes that surround the linear defect. Such structures have been used to create slow light regimes conducive to enhance optical nonlinearities\(^3\), but could also promote the existence of these PQSs. III-V Quantum wells will be combined with these new dispersion regimes, so as to investigate the opportunities of such promising photonic design structures for the generation of short optical pulses within compact platforms\(^4\).

The work will have elements of: (i) theory/photonic design, (ii) device fabrication in clean room environment and (iii) optical characterization and device benchmarking using both experimental and numerical tools.

There will be opportunities to travel and interact with our partners on a national and international level (both Europe/France and Australia) including European industry (CEA-LETI and others).

**References:**

<table>
<thead>
<tr>
<th><strong>Lab/department/team involved in the collaboration</strong></th>
<th>Institute for Photonics and Advanced Sensing (IPAS)</th>
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<tbody>
<tr>
<td><strong>Main contact in the Australian partner institution</strong></td>
<td>Antoine Runge</td>
</tr>
<tr>
<td><strong>Function</strong></td>
<td>ARC DECRA fellow</td>
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<td><strong>Email</strong></td>
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**Outside of this ongoing collaboration, will students from other Australian universities be considered by the hosting institution in France?** Yes

## Expected profile of applicant

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<th><strong>Level of study</strong></th>
<th>Master</th>
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<tr>
<td><strong>Discipline</strong></td>
<td>Photonics</td>
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**Prerequisite knowledge, qualities and skills**

The required skills for the intern will be a good knowledge and a solid background in the field of optics, nonlinear optics, solid-state physics, and semiconductor devices. S/he should work towards his/her Masters/honours or Engineering degree in a field appropriate to one of these areas. An experience in photonics, clean-room fabrication, material deposition or optical modeling and characterization will be strongly appreciated.

**Other specific eligibility criteria**

[Insert citizenship requirements, language requirements or other preferences here]