

Postdoctoral Contract Offer



Project title: Non-linear parametric resonator arrays and spectroscopy of strongly coupled cavity-QED materials

Principal Investigators: Álvaro Gómez-León and Tomás Ramos (@ IFF-CSIC, Madrid)

Project Summary

We aim to uncover **novel many-body effects** in quantum light–matter interfaces as a route to enhance, process, and transfer quantum information with improved quality and performance. Our project focuses on **solid-state quantum platforms**—based on superconducting or semiconducting materials—and explores their potential for advancing quantum technologies. Specific research directions include:

- Nonlinear physics and **parametric topological amplification** in Kerr resonator arrays.
 - Coupling **solid-state quantum emitters** to nonlinear **parametric cavity arrays** to enhance light–matter interactions through squeezing.
 - **Correlation spectroscopy** of complex solid-state systems (quantum dots, Majorana bound states, magnetic molecules) strongly coupled to superconducting microwave resonators.
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Your Role

We are seeking a **junior postdoctoral researcher** with a strong theoretical background in **quantum optics** and/or **condensed matter physics** to conduct research on one or more of the above topics.

The specific project will be adapted to the candidate’s background and interests. Possible tasks include:

- Theoretical modelling of **driven, many-body, open quantum systems** using techniques such as master equations, input–output theory, Floquet theory, and/or stochastic methods.
- Developing and implementing **numerical codes** (Python, MATLAB, or Mathematica) to solve algebraic and nonlinear differential equations.
- Applying **analytical methods** and, when relevant, tools from topological field theory and interacting quantum many-body systems.

What We Offer

- **Contract:** Postdoctoral position funded by the national research project *PID2023-146531NA-I00*.
- **Salary:** 2718 euros gross per month (12 payments).
- **Duration:** 1.5 years, with flexible starting date.
- **Career support:** Assistance in applying for further funding opportunities once integrated in the group.
- **Environment:** The **QUINFOG group** at IFF–CSIC (comprising 6 faculty members, 2 Ramón y Cajal fellows, several postdocs, and PhD students) offers a stimulating and collaborative atmosphere.
- **Location:** Institute of Fundamental Physics (IFF-CSIC), Serrano 113 bis, 28006 Madrid.
- **Collaboration opportunities:** Strong connections with both theoretical and experimental groups at the international level.

How to Apply

Please send an email including:

- A short description of your background and motivation, and
- Your **CV**

to a.gomez.leon@csic.es and tomas.ramos@csic.es.

Deadline: Applications will be reviewed on a rolling basis, until **12 December 2025**. Early applications are encouraged although the starting date is flexible.

Relevant References

[1] “Driven-dissipative topological phases in parametric resonator arrays”, Quantum 7, 1016 (2023). A Gómez-León, T Ramos, A González-Tudela, D Porras.

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[3] “A method for stabilizing nonlinear parametric amplifier arrays and a superconducting quantum parametric amplifier array”, EU Patent EP4622104A1 (18/03/2024). T Ramos, D Porras, A Gómez-León, JJ García-Ripoll, A González-Tudela.

- [4] “Topological input-output theory for directional amplification”. Phys. Rev. A **103**, 033513 (2021). T Ramos, JJ García-Ripoll, and D Porras.
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- [6] Light-matter correlations in Quantum Floquet engineering of cavity quantum materials, Quantum **9**, 1633 (2025). B Pérez-González, G Platero, A Gómez-León.
- [7] “Multi-photon scattering tomography with coherent states”, Phys. Rev. Lett. **119**, 153601 (2017). T Ramos, and J.J. García-Ripoll.
- [8] “Experimental Reconstruction of the Few-Photon Nonlinear Scattering Matrix from a Single Quantum Dot in a Nanophotonic Waveguide”, Phys. Rev. Lett. **126**, 023603 (2021). H Le Jeannic, T Ramos, , P Lodahl.
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- [10] “Complete Physical Characterization of Quantum Nondemolition Measurements via Tomography”, Phys. Rev. Lett. **129**, 010402 (2022). L Pereira, JJ García-Ripoll, T Ramos.
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- [12] Simulation of 1D topological phases in driven quantum dot arrays, Phys. Rev. Lett. **123**, 126401 (2019). B Pérez-González, M Bello, G Platero, A Gómez-León.