Title of the project: Galactic archaeology with high temporal resolution

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Outline of the project and work plan:

The Milky Way is a complex system, with dynamical and chemical substructures, where several competing processes such as mergers, internal secular evolution, gas accretion and gas flows take place. To study in detail how such a giant spiral galaxy was formed and evolved, we need to reconstruct the sequence of its main formation events with high (~10%) temporal resolution.

The ERC *asterochronometry* project will determine accurate, precise ages for tens of thousands of stars in the Galaxy by developing novel star-dating methods that fully utilise the potential of individual pulsation modes, coupled with a careful appraisal of systematic uncertainties on age deriving from our limited understanding of stellar physics.
We will then capitalise on opportunities provided by the timely availability of astrometric, spectroscopic, and asteroseismic data to build and data-mine chrono-chemo-dynamical maps of regions of the Milky Way probed by the space missions CoRoT, Kepler, K2, and TESS. We will quantify, by comparison with predictions of chemo-dynamical models, the relative importance of various processes which play a role in shaping the Galaxy, for example mergers and dynamical processes. The *asterochronometry* project will also provide stringent observational tests of stellar structure and answer some of the long-standing open questions in stellar modelling (e.g. efficiency of transport processes, mass loss on the giant branch, the occurrence of products of coalescence / mass exchange).

More details about the project, including examples of research output from the group, can be found at https://www.asterochronometry.eu.

The project has a strong international outlook and develops in a collaborative environment involving close links with several research groups (https://www.asterochronometry.eu/team.html#external).
Successful applicants will join the Department of Physics and Astronomy, Università di Bologna (https://fisica-astronomia.unibo.it/). The department, together with the adjacent INAF-OAS (https://www.oas.inaf.it/en/) offers a lively and inspiring environment, with about 100 academic and research staff involved in astrophysics.

The three post-doctoral research fellows will be working together and contribute to the two, interweaved, work-packages of the project:

- WP1: High-precision stellar astrophysics,
- WP2: Assembly history and evolution of the Milky Way.

In particular, they will:

- contribute to the delivery of data products (mainly oscillation frequencies from the analysis of CoRoT, *Kepler*/K2, and TESS data) that will be used as input for the stellar modelling efforts in WP1;

- develop seismic diagnostic tools to constrain and stress-test models of the structure and evolution of red giant stars, with specific emphasis on mass loss during the RGB phase, convective-boundary mixing, assumptions about initial Helium abundance, occurrence of products of coalescence and binary evolution;

- test seismically inferred masses and radii against independent benchmarks, in particular eclipsing binaries and clusters;

- lead the data-driven exploitation of catalogues obtained by combining spectroscopic, astrometric, and asteroseismic constraints (in particular ages from WP1), and liaise with surveys (e.g. WEAVE) to ensure the spectroscopic follow-up of the relevant targets;

- develop, validate, and apply methods to dissect the Milky Way's components at various epochs, determine the vertical and radial properties of the Milky Way's discs, quantify the role of secular processes that have shaped the present-day discs, reconstruct their star-formation history with unprecedented temporal resolution, and enable precise inferences on sub-structures in the Milky Way, including their epochs of formation.