

# Dynamical Reconstruction of Galaxies

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## Scientific

Description and aims: The structure of galaxies is shaped both by external processes such as mergers and internal processes like secular evolution. The emergence of Integral Field Unit (IFU) spectroscopic data has been transformative for our understanding of the internal structure of galaxies, providing (through dynamical models) phase-space information on a growing sample of both nearby and high-redshift galaxies. The ability to disentangle coherent dynamical structures in observations is opening new possibilities for reconstructing the formation paths of galaxies. These advances in observations have happened alongside great strides in hydrodynamical cosmological simulations, which are now capable of producing realistic galaxies at high resolutions. These simulations allow the dynamical histories of galaxies to be traced through cosmic time. This helps us to decrypt the stellar dynamical and population memory of build-up of observed galaxies encoded in the orbits as well as age and chemistry of their stars. This workshop aimed to bring together junior and senior researchers working across different areas of observation and theory for a timely discussion on the dynamical reconstruction of galaxies. In particular, the aim was to foster communication between these two communities by offering a mixed program of talks by theorists and observers, as well as providing ample time for discussions.

Tangible outcome: One clear conclusion of this workshop was that no single approach (dynamical modeling, stellar populations and galaxy simulations) can by itself push forward the field. Instead, in order to get a comprehensive theory of how galaxies form their dynamical structures and how these structures evolve, one must combine the three approaches. The various discussion sessions resulted in guidelines of how to practically reconstruct the formation history of galaxies through this combination of stellar populations, dynamical models and galaxy simulations. The more observationally focused discussions resulted in clear conclusions on what is feasible within the near future in terms of IFU data of faint (stellar halos) or blended (thin and thick disks) galaxy components nearby, and IFU data for the very young and far away objects.

Scientific breakthrough: Although combining the three approaches was considered observationally and computationally impossible only a few years ago, various participants presented very recent results that this is indeed possible.

“Aha” moments: The participants realized that junior researchers were in the majority, so that swiftly there was an atmosphere in which people felt comfortable to speak up. Also, deciding to ask juniors to lead the focused groups in the second half of the week was met with surprise at first, but turned out to work excellently and was very much appreciated.

## Organization

Format of the workshop: The workshop was scheduled to have talks only during the mornings, thus leaving the afternoons for discussions and working groups. The week was split into five different topics, one for each day. Each day, the first talk was a review of the particular topic of the day. We chose carefully the five people to give the review to ensure that they go beyond their own research to cover broadly the most recent advances in the respective topic. The other talks were split into invited (25 min), contributed (20 min), and pitches (10 min). In this way, all participants had the chance to present their work, including in particular junior researchers.

During the first two days, we proposed six broad subjects for the afternoon discussions. We asked the participants to vote for the subjects they wanted to attend and decide on a person from each group to provide a brief summary at the end of the afternoon when we all reconvened in the main lecture hall. In this way, we ensured that people would be aware of the parallel discussion sessions that they could not attend. These six topics were on purpose broad, so that for Wednesday and Thursday, we as organizers could distil more focused topics for discussions in smaller groups. We assigned for each group two leading persons, carefully taking into account gender balance and including junior researchers, and asked the participants to come with practical guidelines for each topic. After an initial surprise by such a “direct guidance”, the discussion groups worked out extremely well: everyone got involved, and by the end of the week we received detailed summaries of what’s the status in each particular topic plus extremely useful guidelines (codes, libraries, models).

Other comments: The organizers were committed to a diverse and inclusive workshop. Speakers and discussion leaders were selected to ensure a balance in gender as well as in terms of contributions from established and junior researchers.

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