

IAUS 353 – Executive Summary



Galactic dynamics is fundamental to understanding the formation of galaxies, their internal evolution and their current structure. It also governs interactions between galaxies in systems ranging in size from groups to large clusters of galaxies. While galactic dynamics has traditionally focused on the evolution of the stellar components of galaxies, studies over the past two decades have shown that all aspects of galaxy evolution: star formation, the nature and distribution of stellar populations and the chemical evolution of a galaxy as a whole are strongly influenced by the interplay between the dynamics of stars, gas, and dark matter.

IAU Symposium 353, “Galactic Dynamics in the Era of Large Surveys” was the first major IAU Symposium dedicated to topic of galaxy dynamics in the past decade. The last major conference on Galaxy Dynamics was held in St. Petersburg in 2007. Since then there has been a divergence in the dynamical methods employed to understand the Milky Way (where 3D kinematics of resolved stellar populations observed from our helio-centric perspective are becoming available), and the dynamical methods employed in the study of external galaxies (where wide field line-of-sight kinematics are available for large samples of galaxies). Two primary aims of IAUS 353 were to bring together these diverging communities to ensure that (1) our detailed understanding of the Milky Way and other Local Group galaxies informs our understanding of distant galaxies, their formation and evolution, and (2) the comparison of the Local Group galaxies with external galaxies in turn informs our understanding of the formation and evolution of the Local Group in a cosmological context.

Over 200 scientists from 23 countries gathered in Shanghai for 4.5 days to discuss the major challenges that we are facing in galactic astrophysics. The Symposium brought together observers, simulators, dynamical modelers and theorists to discuss how their diverse expertise and state-of-the-art research techniques and can be combined to address important open questions in galaxy formation and evolution.

Galaxies in the Local Group have seen the largest increase in high quality resolved data resulting in a substantial revision in our understanding of both the structures of the individual galaxies and the dynamical interactions between them. Astrometric data from the Hubble Space Telescope and the Gaia Satellite and spectroscopic data from numerous groundbased surveys have provided three dimensional kinematical data that have enabled us to model both the detailed dynamical structure of the Milky Way and several Local Group

galaxies, but have provide us with a precise knowledge of their past dynamical interactions and the influence of these interactions on the stellar populations of these galaxies.

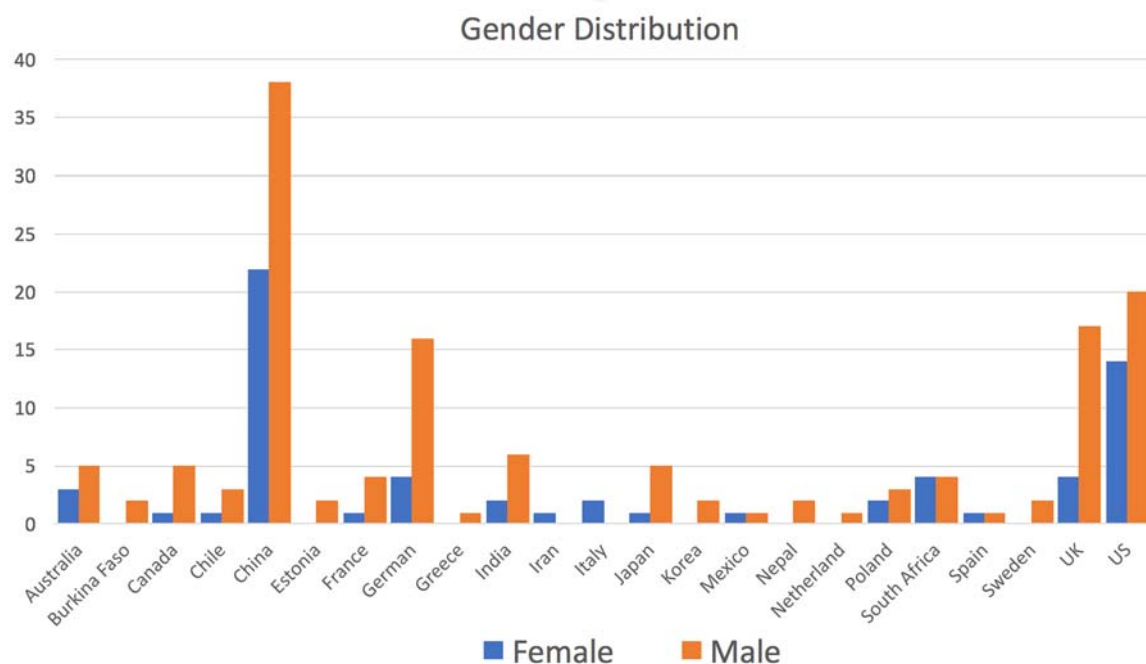
Alongside these developments in our understanding of the very local Universe, there have been significant advances in theoretical understanding of the internal structure and evolution of external spiral and elliptical galaxies. However, it is not yet clear what the relative roles of internal secular evolution and environmental effects are in the cosmological context. It has become clear that bars and spirals drive substantial secular evolution in disk galaxies, though there are still unsolved questions regarding the mechanisms. These structures also transport angular momentum from the inner to the outer disk, scatter stars away from circular orbits contributing to the well-established age-velocity dispersion relation, cause radial migration of stars, smooth rotation curves and disk density profiles, and influence the chemo-dynamical structure of stellar disks. Thus, the present-day properties of disk galaxies are not simply determined by their formation history.

The Symposium provided an important and timely platform to discuss and share ideas on the applications of galactic dynamics to the Milky Way and external galaxies. The key topics included:

- The structure, dynamics, and assembly history of the Milky Way Galaxy
- Dynamical evolution of the Local Group and its members (including M31, the Magellanic clouds, dwarf spheroidal galaxies)
- Dynamical influence of internal secular evolution - the influence of spiral structure, radial migration and bars
- Key dynamical results from large spectroscopic surveys of external galaxies
- Dynamics of bulges, pseudo-bulges, nuclear star clusters and galactic nuclei
- Dynamical modelling of galaxies to measure the mass profiles of baryons and dark matter halos and central supermassive black holes using large integral field surveys
- Dynamics of stellar halos as seen by large surveys
- Dynamics of galaxies at high redshifts

The Scientific Organizing Committee (SOC) identified a total of 40 invited speakers (29 male and 12 female); two female and 4 male invited speakers backed out at a late stage, resulting in a final ratio of 25M: 10F (29% female).

The Scientific Organizing Committee (SOC) reviewed and ranked all submitted abstracts and selected a further 42 contributed oral presentations (14 female ~33%), taking into account scientific impact, gender, geographical distribution and stage of career. Invited talks were allocated 25 minutes, and oral contributions were allocated 12 minutes, including discussion time. 103 poster presentations were also accepted. In total, 201 individuals, 139 males and 62 females (31%), from 23 countries spanning all continents (see attached list of participants) attended. Overall the symposium had 31% female participants. Individual sessions were chaired by members of the SOC and other senior attendees whilst a variety of postdocs and PhD students supported the logistics throughout the sessions. All session chairs were sent an email requesting them to ensure that junior members of the audience were encouraged to ask questions and participate in discussions.



Three open discussions were held during the conference. Moderators were encouraged to discuss with participants prior to the sessions to bring forward a list of topics for discussion. These discussions were fairly productive although the size of the audience and the room were somewhat ill-suited to open discussions. The three discussions were all designed to bring together researchers working on the Milky Way and external galaxies.

Prof. Jo Bovy (CITA) and Prof. Karen Masters (Haverford) moderated a discussion on 'what we have learned about disk galaxies'. The moderators listed several open questions and problems and solicited ideas from the audience for addressing them. Ortwin Gerhard (MPE) moderated an open discussion on 'Galactic nuclei, bars and bulges'. After a brief overview of the current understanding on the barred Milky Way, he summarized the upcoming challenges in this field, including the bulge/bar structure from RCG star count tomography, dynamical models from star counts and radial velocities, new 3D view from VIRAC/Gaia proper motions, and dynamical structure of stellar populations. The discussion reached a final conclusion, that further new data from Gaia and ground-based surveys, and further modelling is likely to lead to improved dynamical constraints and new understanding of the stellar population in the bulge. On the final day Monica Valluri moderated an open discussion on 'the halos of the Milky Way and other galaxies'. She raised several important questions and challenges regarding to the current status of the halo study. Possible improvements on cosmological simulations to better model the Milky Way halo were also discussed.

Two public outreach talks were delivered in the Shanghai Science & Technology Museum to honor and celebrate 100 years of the IAU. Prof. Sellwood (University of Arizona) and Prof. Kormendy (University of Texas at Austin) gave public outreach talks to ~200 audience members half of whom were teenagers in middle school or high school. Prof. Sellwood talked about 'Spirals in Galaxies', and Prof. Kormendy talked about 'Black Holes: Death Stars in the Hearts of Galaxies and Monsters'. Prof. Juntai Shen and Dr. Zhou-Yu Li provided

simultaneous translation from English to Chinese for the two public talks. Both talks were warmly appreciated by the audience who asked over 40 questions.

During the week prior to the Symposium (June 24-28), a free summer school for graduate students and junior researchers was organized. The summer school focused on recent developments in galaxy dynamics. Six international experts (3 male and 3 female) on Galactic dynamics gave two or three lectures each. In addition there were a few afternoon hands-on session where students were able to familiarize themselves with the data analysis software and experiment with simulation data. The lecturers were Jerry Sellwood (University of Arizona), John Kormendy (University of Texas, Austin), Robyn Sanderson (University of Pennsylvania), Monica Valluri (University of Michigan), Eugene Vasiliev (University of Cambridge), and Ling Zhu (Shanghai Astronomical Observatory). This summer school was designed to provide students with some scientific and technical background in galactic dynamics to prepare them for the IAU symposium and to help foster a new generation of galactic dynamicists in the Far East and other developing countries. The lectures (video and slides) from the summer school are available online at: <https://pan.cstcloud.cn/s/hqjYx4SuQdw>

The Symposium proceedings, edited by Juntao Shen, Monica Valluri, and Jerry Sellwood are to be published. In addition to the published proceedings, lectures given at the Symposium are available at the website: <https://pan.cstcloud.cn/web/share.html?hash=OaHRZGsQTgs> and serve both as a permanent record and a learning tool for future students.

In addition to the scientific sessions, the attendees enjoyed a welcome reception on Sunday June 30 and a free afternoon on the third day for sightseeing in Shanghai. The conference dinner was held on the third day, after which the SOC Chair, Juntao Shen, opened the ceremony and introduced the SOC members. During the dinner, the attendees also celebrated the 70th birthday of an influential dynamicist, Jerry Sellwood. The banquet ceremony ended with Jerry Sellwood giving tokens of appreciation to the SOC and LOC members whose outstanding work largely contributed to the success of the meeting.

Juntao Shen, and Monica Valluri as Co-SOC Chairs, were aided in their duties by the other members of the SOC: Gurtina Besla (Univ. of Arizona), Joss Bland-Hawthorn (Univ. of Sydney), Jo Bovy (Univ. of Toronto), Michele Cappellari (Oxford Univ.), Françoise Combes (Obs. de Paris), Dmitri Gadotti (ESO), Ortwin Gerhard (MPE), Amina Helmi (Univ. of Groningen), Woong-Tae Kim (Seoul National Univ.), John Kormendy (Univ. of Texas at Austin).

Juntao Shen & Monica Valluri
Co-Chairs, IAUS 353