Commission X1

Supermassive Black Holes, Feedback and Galaxy Evolution

Rationale for continuing Commission X1

Commission X1 is a Cross-Division one, involving:

Division D (High Energy Phenomena and Fundamental Physics)
Division J (Galaxies and Cosmology)

Proposers:

The initial proposers were Christine Jones, Thaisa Storchi Bergmann, Francoise Combes, William Forman, Fracesco Massaro, Brian R. McNamara, Alastair Edge, Andy Goulding, Andrew Fabian, Julie Hlavacek-Larrondo, Eugene Churazov, Alexander Tchekhovskoy, Dharam V. Lal, Philippe Salomé, Mark Birkinshaw, Diana Worrall, Roberto Maiolino, Ericson Daniel Lopez Izurieta, Huub Rottgering.

Commission X1 has now 405 members. The above proposers support the continuation of the Commission due the large interest in the subject among IAU members of Division D and J, a measure of it being the approximately 30 international conferences dedicated to this subject in the year 2019 alone.

New young proposers for the continuation of Commission X1 include Dr. Jong-Hak Woo, from Seoul National University, particularly interested in joining and contributing to foster its activities considering that the next IAU General Assembly will take place in his country.

Rationale:

The physical processes that couple the growth of supermassive black holes (SMBH) to their host galaxies -- the so-called feedback processes, are now necessary ingredients in galaxy evolution models, not only regulating the growth of the galaxies but also influencing their environment. Observations of radio jets extending to hundred thousand kpc's, of their interaction with ambient gas producing X-ray, optical and infrared emission, relic X-ray cavities observed in galaxy clusters, outflows observed in neutral, ionized and molecular gas, are all observed manifestations of these feedback phenomena. The interplay between the star formation in galaxies and these phenomena are subjects that require a close collaboration between galaxy evolution specialists and researchers studying the effect Active Galactic Nuclei on their host galaxies and vice-versa. Also, a coordinated multi-wavelength observational and combined theoretical effort is key to advancement in this

field. We thus propose to bring together observers from across the electromagnetic spectrum with theorists to understand the interplay between the growth of supermassive black holes and galaxy evolution, from the earliest epochs to the present day Universe.

Why Cross-Division:

As the relevant observations include observations and phenomena at high energy and cover topics of galaxy evolution and cosmology, Commission X1 is relevant to both Division D (High Energy Phenomena and Fundamental Physics) and Division J (Galaxies and Cosmology). The commission has interfaces with several fields such as the high redshift Universe, central to Division J, and mechanisms of AGN, central to Division D. The scientific program e.g., modeling supermassive black holes and modeling galaxy evolution combined with understanding the effects of AGN on star formation and on the energy balance of the interstellar medium (e.g., hot, a few million degrees in early type galaxies and cool in late type galaxies), requires equal participation and access to the expertise in and coordination by both Divisions. The astronomers with the expertise to organize the intended discussion forums and symposia do not reside solely in one IAU Division, but are members of either IAU Division D or J. Thus, it is appropriate that the proposed commission be equally represented ex-officio on the Steering Committees of each Parent Division, and that there be no "Primary Division".

Previous activities:

The main recent activity, that began by mid 2019, was the organization of the IAU Symposium 359 – "Galaxy Evolution and Feedback across Different Environments". The meeting took place March 2-6, 2020, in Bento Gonçalves, south of Brasil, bringing together close to 200 astrophysicists, about 80 students among them and whose outreach activities involved approximately 2000 people.

The continued interest of the astronomical community can be illustrated by the large number of recent conferences devoted to the Commission X1 topics, such as:
"Astrophysics of hot plasma in extended X-ray sources": June12-14, Madrid, Spain;
"Exploring the Energetic Universe": June 17-21, Artana, Kazakhsthan;
"Supermassive Black Holes: environment and evolution": June 19-22, Corfu, Greece;
"Feedback and its role in galaxy formation": June 25-29, Spetses, Greece;
"High energy phenomena in relativistic outflows": July 9-12, Barcelona, Spain;
"A centenary of astrophysical jets: Observation, Theory, and Future Prospects": July 23-26, Manchester, UK;
"Quasars in crisis": August 5-9, Edinburg, UK;
"Active Galaxies and Quasars": September 9-10, Byurakan, Armenia;
"The 3C Extragalactic Radio Sky: Legacy of the Third Cambridge Catalogue": September 16-20, Turin, Italy;
"The Cosmic Baryon Cycle: Impact on Galaxy Evolution": September 19-21, Carlsbad, US;
"IAU Symposium 356: Nuclear Activity in Galaxies Across Cosmic Time": October 7-11, Addis Ababa, Ethiopia;

“Cosmic Evolution of Quasars: from the First Light to Local Relics”: October 21-25, Beijing, China;
“Twenty years or science with Chandra”: December 3-6, Boston, US;
“The Origins of Black Hole Mergers and Gravitational Waves”: December 16-20, Lorentz Center, NL.

Goals and planned activities for the next six years:

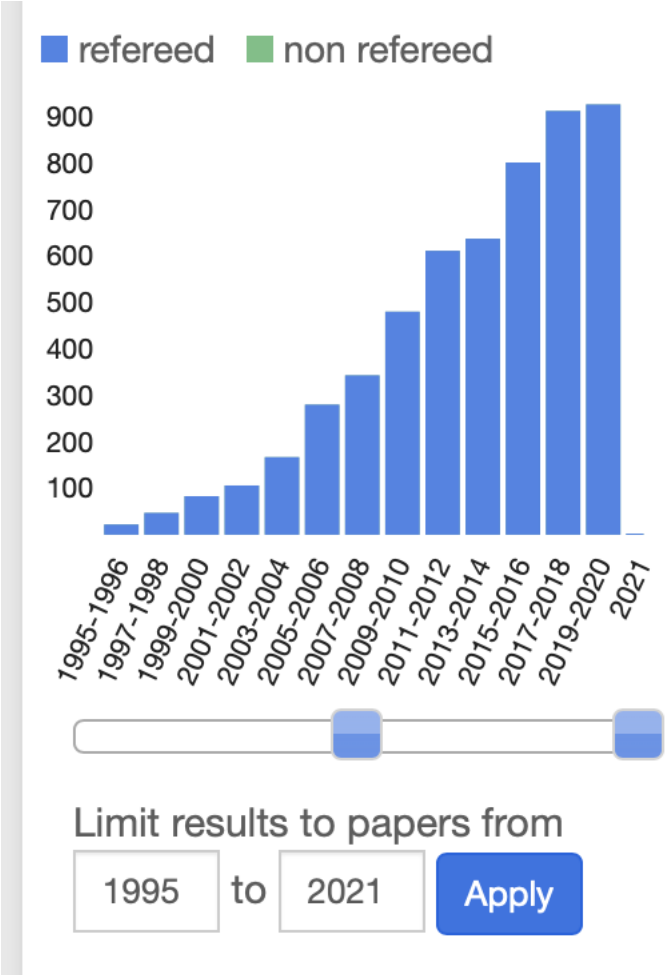
Our main goal is to promote the development of research on Supermassive Black Holes, AGN (Active Galactic Nuclei) and star formation feedback and their role in galaxy evolution. With this commission, we aim at fostering interaction between theorists and observers from across the electromagnetic spectrum in order to investigate the interplay among the growth of SMBHs and galaxies, including the effects of the environment. We intend to bridge the studies on feedback from the "galaxy evolution community", that focus mostly on star formation and evolution, and the `"AGN community", which concentrate on feedback from SMBHs, in order to advance our understanding of galaxy evolution.

To reach this goal, we propose the development and support of the following activities:
-- Work as a forum for discussions about the best observational campaigns;
-- Be a forum for discussion of particular objects or classes of objects to be observed along with needed multi-wavelength surveys;
-- Propose and organize meetings, especially IAU Symposia;
-- Be a forum of discussion about theory and simulations, supporting the dissemination of computing codes;
-- Plan and coordinate sessions at IAU General Assemblies;
-- Prepare a quarterly newsletter to announce meeting deadlines, key science advances, opportunities for collaboration, observing proposal deadlines.

Why continue Commission X1:

A research query to ADS – Astrophysics Data System at Harvard/Smithsonian Center for Astrophysics, using the search [*abs:"feedback" AND (abs:"galaxy" OR abs:"AGN" OR abs:"black hole")*] collection:astronomy property:refereed results in 5500 papers (refereed; the figure shows only the refereed papers and starts at 1996 to emphasize the growth).

This evidently shows that the interest in this topic is still strong, and still apparently growing among the extragalactic astronomy community.



Recent observational initiatives also ensure that the impact of Commission X1 will continue throughout the decade of the 2020s. While JWST is not yet launched, other space and ground based initiatives are underway. The Spectrum-Roentgen-Gamma mission was successfully launched on 13 July 2019. Following an initial performance verification phase, it has begun its prime survey mission - eight complete surveys of the entire sky, one every six months, for the next 4 years. Based on the performance verification observations, in a survey of about 1/300 of the entire sky to the depth of the final survey, eRosita detected more than 15,000 AGN and more than 400 galaxy clusters. This verifies the pre-launch predictions that the survey will detect of order 100,000 galaxy clusters and more than four million AGN. Radio surveys in both the southern and northern hemispheres are well underway. In the radio regime, the LOFAR, GMRT, ASKAP-EMU surveys are providing remarkable insights into high energy processes and feedback by discovering all manner of new types of objects requiring detailed multi-wavelength followup. Detailed studies at high redshift will be possible with future, more powerful observatories, both on the ground (notably E-ELT, GMT, and TMT in the optical and infrared and JVLA, SKA, GMRT, LOFAR in the radio) as well as space missions (e.g., James Webb, WFIRST, Athena, ATLAST, SMART-X). With the already operating facilities, and more to come, the exploration of “Supermassive Black Holes, Feedback and Galaxy Evolution” already is assured to have exciting advances.

Thaisa Storchi Bergmann and the Organizing Committee of Commission X1