

**INTER-DIVISION D-G-H-J
COMMISSION J1**

**GALAXY SPECTRAL
ENERGY DISTRIBUTIONS**

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Commission J1 WG**

**Reference Library of Galaxy
Spectral Energy Distributions
(RELIGAS)**

TRIENNIAL REPORT 2018–2021

by Cristina Popescu (President) and Nikolaos Kylafis (Vice-President)

The spectral energy distribution (SED) of galaxies represents a coded signature of the various and complex interactions between photons and matter in galaxies. In particular, the SEDs contain information on the baryonic content of galaxies - stars, dust and gas - as well as cosmic rays and magnetic fields. If it can be extracted through the decoding of the SEDs, this information will allow the main physical processes shaping galaxy evolution, and their dependencies on the environments of galaxies, to be identified and quantified. Thus characterised, these physical processes may then be subjected to more detailed scrutiny in specialised communities, as well informing numerical calculations of the formation and evolution of galaxies, most especially on scales where ab initio physical theories are not yet available.

Thus, because of the multiwavelength dimension of the galaxy SEDs, and of the large variety of physical processes involved, galaxy SEDs are of interest for many different astrophysical communities, both observational and theoretical. Accordingly, the mission of Commission J1 “The spectral energy distribution of galaxies” is two fold: Firstly, - to bring together observers and theoreticians working in different fields of astrophysics: galaxy formation and evolution, cosmology, interstellar matter, our Galaxy and the nearby universe, stars and stellar evolution, high energy astrophysics and astro-particle physics to tackle current challenges in modern astrophysics through galaxy SEDs. And secondly, - to promote self-consistent modelling approaches for galaxy SEDs.

With the new observing capabilities that are on the horizon, JWST, SKA, the Vera Rubin Observatory, the Nancy Grace Roman Space Telescope, EUCLID, ATHENA, ELTs, CTA, the galaxy SEDs at higher and higher redshifts will become available, and resolved SEDs of smaller and smaller scale structures within galaxies will become available in the nearby universe. We anticipate that the mission goals of the Commission will become ever more relevant in the next 6 years.

Commission J1 was founded in August 2015 as an Inter-Division Commission, shared between Division D “High Energy Phenomena and Fundamental Physics”, Division G “Stars and Stellar Physics”, Division H “Interstellar Matter and Local Universe”, and Division J “Galaxies and Cosmology”, with Division J as the parent division of this Commission. Denis Burgarella was its first President and Cristina Popescu was its first Vice-President. In 2018 Cristina Popescu took over as President of the Commission, with Nikolaos Kylafis being elected Vice-President of the Commission.

At the beginning of the new term, in 2018, Commission J1 started with an evaluation of the number and distribution of its members. On the 1st of September 2018 there were 198 members listed on the webpage of the Commission. The analysis showed that most of its members belonged to the parent Division J, with some representation from the other Divisions related to our inter-Division Commission. The poorest representation amongst members was from Division D. Because of this a call was sent to members of Division D expressing interest in their larger participation in our Commission. This was achieved with the cooperation of the President of Division D, Prof. Elena Pian. This initiative proved successful, with requests from members of Division D to join Commission J accounting to 5% increase in the total number of members of our Commission.

The analysis of the geographic distribution of the members of Commission J showed a very wide spread, amongst all continents and a large numbers of countries, including countries with smaller astrophysics communities. However, the analysis of the gender distribution revealed that only 28% of the members of Commission J1 are female.

During this term the number of members increased by 11%. Of this, 5% was due to the initial increase with members of Division D, as mentioned above, while the rest of 6% is due to members that joined during the course of the term and to the more recent addition of junior members. It is encouraging to see that the young generation embraces the goals of Commission J1, and it is hoped that this positive trend continues.

One other task of the Commission was to evaluate the activity of the two working groups created by the Commission in the previous term: “Reference Library of Galaxy Spectral Energy Distributions (RELIGAS)” and “Inter-Commission B2-J1 WG From Databases to Spectral Energy Distributions (DB2SED)”. The original goal of RELIGAS was to define a set of SEDs that could be used by the astronomical community. The idea was to identify an ensemble of already existing galaxy SED libraries and to produce reports summarizing the principle properties of SED templates and models, their applicability (i.e., to particular science goals and galaxy classes), and to suggest ways to improve them and identify key missing object classes. The original goal of DB2SED was to make recommendations on how to optimize the use of databases to feed codes studying the galaxy SEDs. After consultation with the chairs of RELIGAS (Michael Brown and Carlotta Gruppioni) and DB2SED (Samir Salim and Anja Schröder) it was concluded that they should merge into a single one, since the aims of the two were not too dissimilar, and that they would gain if a coherent approach would be established within a renewed WG, which would keep the name RELIGAS. The merged Working Group RELIGAS has continued its activities with the new appointed chairs Carlotta Gruppioni and Samir Salim (see their report). The WG retained Michael Brown and Anja Schröder as Advisors

to the Chairs. The chairs concluded that the WG reached its goals during the two terms and did not recommend continuation to the next term.

One declared goal of the President of Commission J1 was to strengthen the embracing of the high-energy community within the Galaxy SEDs Commission. The idea was to create a new Working Group, “Linking the Imprint of Low and High Energy Processes on Galaxy SEDs”. The main goal was to explore astrophysical connections between thermal and non-thermal components in galaxies, with the aim of identifying missing links that can be established between the high-energy astrophysics community, in particular the gamma-ray community and the extragalactic community analysing SED of galaxies, in particular the infrared community. These links were envisaged both in terms of identifying physical processes that can be solved in a self-consistent way through theory and modelling, but also in terms of sharing methods and techniques. The ideas were discussed with the members of the Organising Committee, but also with the parent Division J and with the relevant Division H. The new Working Group was given the green light to start its activity just before the pandemic started. The proposed chairs decided to organise a workshop at the MPIK-Heidelberg, and that the contributing participants would become members of the working group, according to the relevance of their contributions. Unfortunately the workshop was continuously postponed due to the pandemic, and never organised as an on-line workshop. As such, any activity on this topic would need to be re-established in the next IAU term.

In 2018 and 2019 Commission J1 received requests for support of IAU Symposia proposals, and had an approved symposium in each year: “Predictive power of computational astrophysics as a discovery tool” (chair Dmitry Bisikalo), which was successfully approved as the IAU Symposium 362, and “Resolving the Rise and Fall of Star Formation in Galaxies” (chairs Tony Wong and Eva Schienerer), approved as IAU Symposium 373. In 2020, due to the Covid pandemic, an overall small number of proposals were received by the IAU, and our Commission received no requests at all.

Prior to the pandemic there have been many non-IAU conferences and meetings which embraced the goals of Commission J1 (e.g. “Dusting the Universe”, chairs: Stacey Alberts and Irene Shivaiei; “Through Dark Lanes to New Stars”, chair Joao Alvez), with fewer continuing on-line during the pandemic (e.g. “Astronomical Surveys and Big Data 2”, chair Areg Mickaelian); “The rise of metals and dust in galaxies through cosmic time”, chair: Denis Burgarella and Carlotta Gruppioni), showing the critical relevance of the Commission in the most topical subjects chosen by the community.

During this term an important topic for Commission J1 has been discussed in a text book that is in press with Cambridge University press: “Star-Formation Rates in Galaxies” (DOI: 10.1017/9781316875445), with the editors Veronique Buat and Andreas Zezas both members of Commission J1. The book will represent a useful reference for students and researchers working in the field of studying the star-formation in local and higher-redshift galaxies, and brings together comparative discussions of traditional and new star-formation rate indicators, star-formation rate measurements on different spatial scales, as well as methods to derive star formation rates from the panchromatic spectral energy distributions of galaxies. The different chapters of the book were written by specialists in the field, with many of them members of Commission J1. In particular the Advisor of Commission J1, Denis Burgarella authored the Chapter “Star Formation Rates from Spectral Energy Distributions of Galaxies”, the President, Cristina Popescu authored the Chapter “Modelling the Spectral Energy Distributions of Star-Forming Galaxies with Radiative Transfer Methods”, and the member of the Organising Committee, Médéric Boquien co-authored the Chapter “Continuum and Emission-Line Star-Formation Rate Indicators”, jointly with Commission J1 member Daniel Dale. Commission member An-

dreas Zezas discussed the emerging “High-Energy Star-Formation Rate Indicators” , while Commission member Brent Groves detailed “Measuring the Star-Formation Rate in Active galactic Nuclei”.

At the end of 2020 the President and the Organising Committee members of Commission J1 put together a proposal for the Commission to be continued for another 6 years, proposal that was approved by the IAU and its members. The proposal highlights some directions on which the Commission should capitalise in the next 6 years, as follows:

- continue to promote inter-disciplinary research between different fields of astrophysics, both theoretical and observational, maximising science impact of existing data archives and modelling algorithms in the context of galaxy SEDs
- facilitate collaborative projects for new observatories with strong potential for scientific leverage by linking different parts of the electromagnetic spectrum covered by existing or planned observatories
- support the participation of under-represented minorities in the different fields of research linked to galaxy SEDs
- promote the awareness of students and early career researchers to opportunities of cross-field research by organising and supporting school-type meetings linked to the theory and analysis of galaxy SEDs