

DIVISION J

GALAXIES AND COSMOLOGY

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TRIENNIAL REPORT 2018–2021

1. Activities of IAU Division J during 2018-2021

by Denis Burgarella (President)

2. Introduction

The division Galaxies and Cosmology of the International Astronomical Union (IAU) covers all thematics dealing with the physics of the Universe, and the physics of galaxies composing it, but not in particular the Milky Way, which is relevant to Div.H (“Interstellar Matter and Local Universe”). Also, some of the topics will be shared with Div.D (“High Energy Phenomena and Fundamental Physics”).

As written on the webpage of Division J, the main topics can roughly be classified in four categories and sub-categories listed below:

- Physics and content of the Universe
 - The early Universe, cosmological models;
 - Baryonic and non-baryonic matter, dark matter and dark energy.
- Evolution of structures
 - Cosmic backgrounds (CMB, and all backgrounds from radio to gamma-rays);

- Populations of galaxies, galaxy clusters and groups, intergalactic medium.
- Formation and evolution of galaxies
 - Reionization, first objects (AGN, Starbursts), history of star formation;
 - Physics of galaxies at all redshifts, role of the environment.
- Spatially resolved galaxies
 - Star formation laws in galaxies, resolved stellar population;
 - Dynamics of sub-structures (bulges, disks, spiral structure...).

Before describing the activities of the Division J, Galaxies and Cosmology, it is probably useful to stress two important events that might be kept in mind when thinking about the 2018 - 2021 Triennium.

2.1. *Impact of a non-astronomical event to the activities of Division J*

The first one is certainly negative, it is the fact that 2020 and at least partially 2021 have been strongly impacted by Covid-19 in various ways. First, because the IAU General Assembly could not be held in Busan, South Korea. And with the General Assembly, most of the scientific activities that usually happens during this long-awaited meeting, i.e., symposia and focus meetings. But beyond the meetings themselves, the sanitary situation hampered all the stimulating discussions and informal events that is a way of seeding scientific activities and developing new collaborations[†].

However, we also need to think to the human impact of Covid-19. A large part of the world population had to stay at home, with much less interactions with colleagues, and very likely less new collaborations and new ideas as well? We need to think to all the members of Division J who have been directly impacted by illness or even death in their private circles, and to many more who have suffered psychologically. Moreover, Covid-19 will certainly severely affect people through so many ways (that can hardly be quantified), especially for young researchers but also for gender balance, inclusion & diversity, and in family circles where poor working conditions might certainly had a bad impact on the scientific production (Deryugina, Shurchkov & Stearns 2021; Myers et al., 2020) but also simply on education[‡]. Hopefully, all of this will resume in 2022.

2.2. *1920-1924: the start of Galaxies and Cosmology*

The second one is more positive. It seems useful and even important to write in this report that the Universe as we know it now, is only 100 years old. It was in April 1920 that the Great Debate was held at the Smithsonian Museum of Natural History, between Shapley and Curtis on the nature of spiral nebulae and the size of the Universe. From the presentations, two papers have been published by Shapley and by Curtis in the May 1921 issue of the Bulletin of the National Research Council (Shapley & Curtis 1921). Shapley supported the idea that distant nebulae were relatively small and lay within the outskirts of what is now called the Milky Way, while Curtis was convinced that these nebulae were actually other, independent objects such as our galaxy, the Milky Way. Following Curtis' view had strong implications and implied that galaxies were very large objects at very large distant from Earth. Only in 1924, Hubble's detection of cepheids and other variable stars in some of these nebulae (e.g., NGC 6822, M331, M32 et M31), allowed to estimate the distance to these nebulae, showed that they are indeed extragalactic objects and closed this Great Debate. The end of this debate is therefore the spiritual birthdate of the Division Galaxies and Cosmology. During the past triennium (2018 - 2021), we could have celebrated the start of the Great Debate but we suggest that we could do it better

[†] <https://www.universetoday.com/145881/how-will-covid-19-affect-the-future-of-science/>

[‡] <https://www.unicef.org/press-releases/unequal-access-remote-schooling-amid-covid-19-threatens-deepen-global-learning>

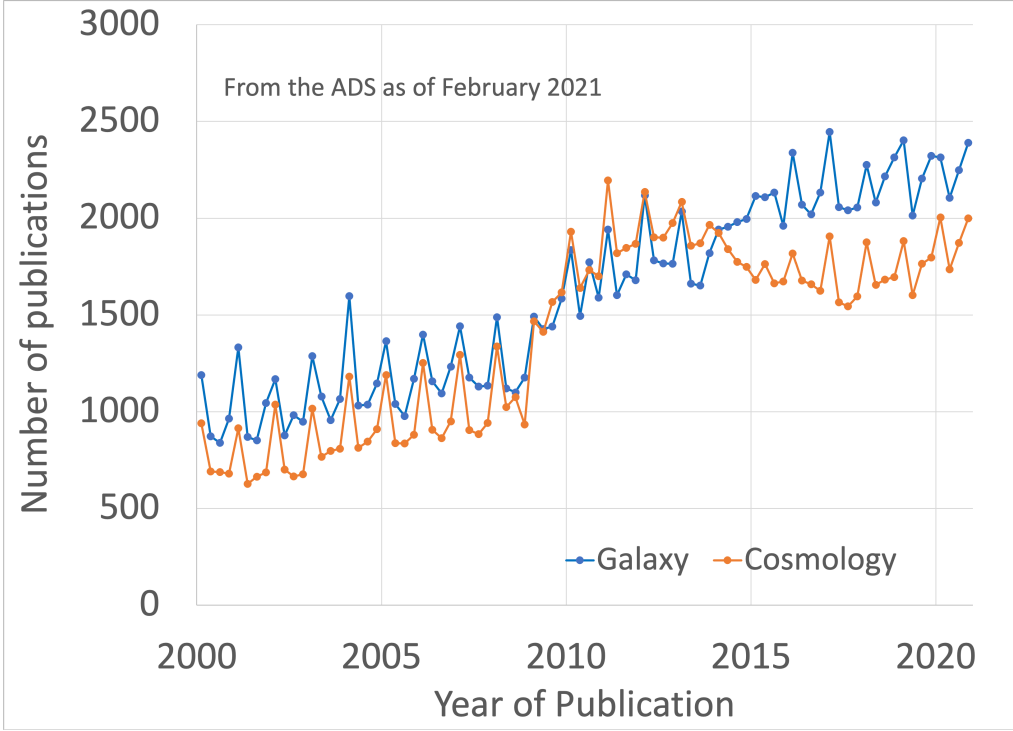


Figure 1. Papers with the word *galaxies* and papers with the word *cosmology* in the abstract from the Astrophysical Data System (ADS, as of February 2021). We see a global increasing trend for both words with a bump in the years 2010 to 2014 that might be attributed to the Herschel ? Planck ESA couple. Note also that there is a regular peak in the distributions. They almost all correspond to the first quarter of each year, maybe because there is a rush to submit papers at the end of the previous year that are actually publish at the beginning of next year. No clear effect of the Covid-19 pandemic is observed until February 2021.

during the next triennium (2021 - 2024) and more specifically to hold a special even during the next IAU General Assembly.

2.3. The evolution of the publication rate for *Galaxies* and *Cosmology* during the first fifth of the XXIst century

Knowing this is debated and contains weaknesses (e.g. Bornmann & Werner, 2018), we will try to estimate how the publication rate for *Galaxies* and *Cosmology* evolved during the first fifth of the XXIst century by looking to the abstract of refereed papers themselves, selecting those with the word *galaxies* and with the word *cosmology*. Practically, we interrogated the Astrophysical Data System (ADS) as shown in Fig. 1.

The main information that we can draw from Fig. 1 are the following ones:

- There is a general trend for the number of publications to increase both for *Galaxies* and for *Cosmology*.
- There are regular peaks in the distributions, again both for *Galaxies* and for *Cosmology*. They seem to suggest that there is a surge of publication in the first quarter of each year, presumably related to papers submitted during the last quarters of each year.
- There is a big bump in the years 2010 - 2014, both for *Galaxies* and *Cosmology*. A possible interpretation is related to the launch and the exploitation of the two missions from the European Space Agency (Planck and Herschel).

• Finally, to answer the question of the impact of Covid-19 on the publications rate of Division J, the apparent conclusion seems that if there will be any effect, it is not apparent yet.

2.4. Regular activities of Division J

During the last year, we worked on the selection for the PhD prize and for the selection of symposia and focus meetings that should have been held during the IAU General Assembly in Busan, South Korea.

For the PhD prize, the Division J Galaxies and Cosmology had the pleasure to select Anna-Christina Eilers, Germany, for her work on " *Unravelling 13 Billion Years of Cosmic History with Spectroscopic Studies: From the Milky Way to the Epoch of Reionization*". This work, is twofold: 1) how did supermassive black holes, which reside in every galaxy's nucleus, emerge so quickly after the Big Bang, apparently in violation of the Eddington limit? and 2) what is the shape of the Milky Way's stellar rotation curve at large galactocentric distance?

Because of the pandemic, few meetings were held in 2021 and 2020 but more in 2019:

- Mar 2 - Mar 6, 2020: IAUS 359 *Galaxy Evolution and Feedback Across Different Environments*, in Bento Goncalves, Brazil
- Nov 18 - Nov, 2020: *Challenges and Innovations in Computational Astrophysics - II*, virtual Meeting
- Oct 7 - Oct 11, 2019: IAUS 356 *Nuclear Activity in Galaxies Across Cosmic Time*, in Addis Ababa, Ethiopia
- Jul 8 - Jul 12, 2019: IAUS 355 *The Realm of the Low Surface Brightness Universe* in Tenerife, Spain
- Jun 30 - Jul 5, 2019: IAUS 353 *Galactic Dynamics in the Era of Large Surveys* in Shanghai, China, Nanjing
- Jun 3 - Jun 7, 2019: IAUS 352 *Uncovering early galaxy evolution in the ALMA and JWST era* in Viana do Castelo, Portugal

References

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 Myers et al. (2020, Nature Human Behaviour 4, 880)
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