

An Oxford New College-Johns Hopkins Centre for Cosmological Studies

Joseph Ivor Silk

**2011 Balzan Prize for The Early Universe
(from the Planck Time to the First Galaxies)**

Balzan GPC Adviser: Bengt Gustafsson

Project Directors: Chris Lintott (Project Director); Adrienne Slyz, Marc Kamionkowski, John March-Russell (Advisory Committee)

Researchers: Debika Chowdhury, Deandra Cutajar, Harry Desmond, Rebekka Bieri, Salvatore Cielo, Ryan Brennan, Julien Devriendt, Mark Richardson, Irina Dvorkin, Alessandro Lupi, Dipanjan Mukherjee, Marina Trevisan

Affiliated Institution: New College, University of Oxford

Period: 2013-2017

Website: <http://balzan.new.ox.ac.uk/>

Joseph Ivor Silk is at the Institut d'Astrophysique of the Pierre and Marie Curie-Sorbonne Universities in Paris. He is also Homewood Professor in the Department of Physics and Astronomy at Johns Hopkins University in Baltimore, Fellow at New College, and Senior Fellow in the Beecroft Institute of Particle Astrophysics and Cosmology of the Department of Physics at the University of Oxford.

Silk has designated part of his Balzan research funds for the creation of a Centre for Cosmological Studies based at New College Oxford and at the Department of Physics and Astronomy at the Johns Hopkins University in Baltimore. It also involves the Oxford University Department of Physics and the Institut d'Astrophysique of the Pierre and Marie Curie-Sorbonne Universities in Paris. The Centre's goal is to provide Balzan grants for young researchers in cosmology in frontier areas of research that are consistent with the scientific themes supported by the Centre, and to establish international links among leading young researchers to develop scientific interactions and collaborations that will benefit their careers as well as enhance the scientific life of the partner institution.

The first grants were awarded in the autumn of 2013 to Visiting Junior Research Fellows hosted at the institutions mentioned above. During the first three years of operation of the Oxford New College-Johns Hopkins Centre for Cosmological Studies, some twenty-four young researchers were hosted at the participating institutions for periods of up to two months each. The researchers were selected from a large field of candidates, and chosen because of their outstanding science potential and their interactivity with cosmology faculty at the participating institutions. The goal is to choose brilliant young researchers who will boost their careers by developing new collaborations. Several visited New College, while others were at the Johns Hopkins University at IAP, Paris.

The New College Balzan fellows initiated a series of Balzan Conversations, well-attended informal discussions about their research, to which the New College fellowship as well as undergraduate and postgraduate physics students were invited. New College Balzan guests also participated in many high table and lunchtime discussions with fellows. Their research interests spanned subjects including the origin of cosmic structure and the fossil radiation echo from the Big Bang.

An indication of the success of the programme may be gleaned from the fact that nearly 50% of the researchers were doctoral students and one-third were female, all first-choice candidates and highly likely to continue successful careers in research boosted by the opportunity offered by the Balzan grant to Silk for enabling them to become better acquainted with leading institutions. As in previous years, in 2016-2017 researchers were selected from a large field of candidates, chosen with support from faculty at each institution and based on their potential to carry out outstanding work of international importance. While the centres work remains focused on cosmology, 2016-2017 has seen a broader scientific reach than ever before. Moreover, the program reaches participants at crucial times in their careers, namely at the end of their PhD work or in transition to a first postdoctoral fellowship. Balzan funds help them make these transition points scientifically productive, thus ensuring that Balzan scholars go on to great careers.

2017 candidates: Debika Chowdhury, a doctoral researcher at the Indian Institute of Technology in Madras, visited the Institut de Astrophysique in Paris to work on the study of the phase space of initial conditions for inflationary models. Deandra Cutajar, a doctoral researcher at the Institute of Space Sciences and Astronomy at the University of Malta, visited the University of Oxford to conduct research related to

the noise bias reported in shear lensing measurements, developing a new algorithm to be tested and confronted against noise galaxy image situations. Harry Desmond, doctoral researcher at the Kavli Institute for Particle Astrophysics and Cosmology at Stanford University, also visited Oxford. He is engaged in work to lay the groundwork for a systematic investigation of gravity at the galaxy scale by mapping out the gravitational field over the galaxy environments which exist in the local universe. Results were published in 2018.

2016 candidates: Rebekka Bieri, a postdoctoral researcher at the Institut de Astrophysique in Paris, visited the University of Oxford to work on radiation-driven AGN feedback in high-redshift galaxies, with an article published in 2017. Salvatore Cielo, another postdoctoral research at the Institut de Astrophysique in Paris, also visited the University of Oxford, where he focused on the development of new techniques involving numerical simulations (starting with his work on models for AGN feedback in galaxies) and presented some recent results on jets in galaxy clusters and individual galaxies. Ryan Brennan, a postdoctoral researcher from Rutgers University, visited the University of Oxford to work with Julien Devriendt and former Balzan fellow Mark Richardson to learn how to work with the outputs of the Horizon-AGN and Horizon-noAGN simulations in order to begin a project to mock observed winds launched by feedback in simulated galaxies. Irina Dvorkin, a postdoctoral researcher at the Institut de Astrophysique in Paris, visited Johns Hopkins University to work with Professor Silk to develop a framework that combines galaxy and stellar evolution models and use it to predict the detention rates of merging binary black holes by Advanced LIGO. Alessandro Lupi, a postdoctoral researcher at the Institut de Astrophysique in Paris, visited Johns Hopkins University to work on the effect of super-massive black hole binaries (MBHBs) on the – possibly present – dark matter spike formed around the most massive black hole (MBH). Dipanjan Mukherjee is a postdoctoral research at the Research School of Astronomy and Astrophysics at Australian National University in Canberra. He visited Johns Hopkins University to engage in research simulating how relativistic jets affect the host galaxy’s interstellar medium (ISM) before affecting gas at large extragalactic scales. Together with Professor Silk, he identified new potential areas of investigation focusing on the effect of intermediate mass black holes on smaller dwarf galaxies. Publications are in preparation. Marina Trevisan, a postdoctoral researcher was hosted by Gary Mamon at the Institut de Astrophysique in Paris, where she tackled questions associated with quenching the star formation in galaxies up to large cluster centric distances. The outcome of her study will have

important implications for understanding how the large-scale environment affects galaxy evolution.

For further information on Silk's research project awardees from 2013 to 2015 and their publications, see the fourth edition of the *Overview* on the International Balzan Foundation Website: <http://www.balzan.org/en/prizewinners/joseph-ivor-silk/research-project-silk>.

Publications

The following list includes publications of the following former participants in Joseph Silk's research project: Razieh Emami Meibody (2015), Joakim Rosdahl (2015), Cora Uhlemann (2015), Francesco De Bernardis (2014), and Zachary Dugan (2014).

- Bieri, R., Y. Dubois, J. Rosdahl, et al. 2017. Radiation driven AGN feedback in high-redshift galaxies. *MNRAS*, 464, 1854.
- Desjacques, V., J. Chluba, J. Silk, F. De Bernardis, O. Doré. Submitted March 2015. Detecting the cosmological recombination signal from space. arXiv:1503.05589.
- Desmond, H., P.G. Ferreira, J. Lavaux, J. Jasche. 2018. Reconstructing the gravitational field of the local universe. *MNRAS*, 474, 3152.
- Dugan, Z., S. Bryan, V. Gaibler, J. Silk, M. Haas. 2014. Stellar signatures of AGN-JET-triggered star formation. *The Astrophysical Journal*. Vol. 796, no. 2. DOI 10.188/0004-637X/796/2/113.
- Emami, R., E. Dimastrogiovani, J. Chluba, M. Kamionkowski. 2015. Probing the scale dependence of non-Gaussianity with spectral distortions of the cosmic microwave background. *Phys. Rev. D* 91, 123531.
- Emami, R., H. Firouzjahi. 2015. Clustering fossil from primordial gravitational waves in anisotropic inflation. *Journal of Cosmology and Astroparticle Physics*. DOI 10.1088/1475-751/2015/10/043.
- Uhlemann, C., S. Codis, C. Pichon, F. Bernardeau, P. Reimberg. Submitted 17 December 2015. Back in the saddle: Large-deviation statistics of the cosmic log-density field. arXiv:151205793.