

# RadioNet support for Short Term Missions (staff exchange)

## Application form

STM INFORMATION	
APPLICANT 'S NAME	Gabriele Bruni
APPLICANT'S AFFILIATION	Istituto di Astrofisica e Planetologia Spaziali (IAPS-INAF) via Fosso del Cavaliere, 100 - 00133 Rome (Italy)
HOST INSTITUTE	Istituto di RadioAstronomia (IRA-INAF) via Piero Gobetti, 101 - 40129 Bologna (Italy)
DATE OF THE STM	06-17/11/2017
TOTAL COST OF STM	1200 Euros
OTHER SOURCES OF FUNDING	None

Topic	<p><b>GIANT RADIO GALAXIES: CLUES OF THEIR ORIGIN FROM INTEGRAL DETECTIONS</b></p> <p>A fraction of radio galaxies (~ 6% in the 3CR catalogue, Ishwara-Chandra &amp; Saikia, 1999, MNRAS, 309, 100) exhibits amazing linear extents, i.e. above 0.7 Mpc, making them the largest individual objects in the Universe. Both Fanaroff-Riley type I and type II radio galaxies (FRI and FRII respectively, Fanaroff &amp; Riley, 1974, MNRAS, 167, 31) are represented in samples of giant radio sources. While FRI giant radio galaxies (GRG) are associated with early type galaxies, those with FRII morphology are hosted both in early type galaxies and quasars. Lara et al. (2001, A&amp;A, 370, 409, and 2004, A&amp;A, 421, 899) studied the statistical properties of a sample of GRG selected from the NVSS, and found roughly the same fraction of FRI and FRII sources, the FRIIs extending to much higher redshift.</p> <p>The samples of GRG available in the literature, mainly drawn from all sky radio surveys such as NVSS, SUMSS, WENSS, have been used to test models for radio galaxy evolution (i.e. Blundell et al., 1999, ApJ, 172, L37). Despite the overall uncertainties lying under the assumption that spectral ages of radio galaxies are representative of their dynamical ages (Parma et al., 1999, A&amp;A, 344, 7), it seems plausible that GRG are on average very old sources, with radiative age in excess of <math>10^8</math> yr.</p> <p>Beyond the source age, the main intrinsic parameters which allow a radio galaxy to reach a linear size of the order of the Mpc during its lifetime are still unclear. The role of the external medium is difficult to evaluate, not to mention that the density of the medium surrounding the jets and lobes may change considerably over the large scales considered here. Some GRGs are associated with the dominant member of a galaxy group (as is the case for instance the FRI GRG NGC 315, Giacintucci et al. 2011, ApJ, 732, 95), while others have been detected at high redshift in a likely less dense medium. This has been confirmed more quantitatively by Machalski et al. (2004, Acta Astronomica, 54, 249), in a comparative study of GRGs and "normal sized" radio galaxies. Those authors also concluded that the jet power and the central galaxy density seem correlate with the size of radio galaxies. All in all, however, the origin and evolution of GRGs remains substantially unknown.</p> <p>Starting from 2002, the <math>\gamma</math>-ray sky has been surveyed by INTEGRAL (International Gamma-Ray Astrophysics Laboratory) in the energy range 5 keV to 10 MeV. Up to now five catalogues have been released, the most recent one comprising more than 1000 high energy sources (Bird et al., 2016, ApJS, 223, 15), with 39%, unambiguously associated with AGN. Both radio-quiet and radio-loud sources are detected at gamma-ray energies.</p>
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Proposed work	<p>Our group is devoting an effort to the multi-wavelength study of a sample of soft gamma-ray-selected GRG. Bassani et al. 2016 (MNRAS, 461, 3165) undertook a radio/gamma-ray study of the INTEGRAL-Swift AGN population, and found 64 of them to be associated with extended radio galaxies with measured redshift. They belong to both the FRI and FRII morphological classes. Inspection of NVSS and SUMSS reveals that 15 of them are GRG, i.e. 25% of the sample. Considering the overall fraction of giant sources in samples of radio galaxies (1-6%), this fraction is impressive, and suggests a tight link between the nuclear/accretion properties of the AGN and the radio source size.</p> <p>We have collected GMRT deep observations for a pilot sample of GRG, selected among the ones above, with the aim of studying: a) the radiative age along the lobes of the source structure; b) the morphological and spectral properties of the nuclear component; c) signs of restarting radio activity, to obtain a global view of the lifecycle of these GRG. In addition, we are collecting ancillary data from archives at different spatial scales (both VLBI and local interferometers) in the cm-band, to test possible re-orientation scenarios, or signs of interaction with the environment. The applicant visit will be of crucial importance, giving the opportunity to work with skilled radio astronomers at IRA-INAF (T. Venturi, D. Dallacasa) to obtain insight into low-frequency interferometry techniques. The GMRT dataset will be fully reduced and analyzed, and results published in one of the main journals of the field (A&amp;A, MNRAS, ApJ).</p>
Cross-disciplinary	<p>The applicant, based at IAPS-INAF, will contribute to the dissemination of radio astronomy knowledge in his home institute - mainly devoted to high-energy astrophysics - bridging the two communities historically present in Bologna and Rome. Multi-wavelength astronomy is becoming more and more important as next-generation radio telescopes are being developed and commissioned: this collaboration is one of the main steps INAF is undertaking to develop cross-disciplinary studies in the AGN field. The group has an extensive experience in X-ray astronomy, that already gave fruitful results through the combined X-ray/Radio analysis of GRG (Molina et al. 2014, A&amp;A 565, A2; Molina et al. 2015, MNRAS 451, 2370).</p>
Impact	<p>The planned research activity will help the applicant in reinforcing his multi-wavelength experience. These competencies will be immediately transferable during future working activity at research institutes and universities. The cumulated experience and attitude in using world-class instrumentation will also be an indispensable knowledge in the exploitation of the next generation telescopes (SKA, ALMA, JWST) thus guaranteeing the candidate a excellent background to join key science projects or international groups in the next years. IAPS-INAF is actively involved in the joint PhD program offered by “La Sapienza” and “Tor Vergata” universities in Rome. Thus, the applicant will guarantee a return of knowledge on the new astronomers generation, contributing to the supervision of both PhD and Master students for different projects.</p>

Curriculum Vitae	<p><b>FORMATION AND CAREER</b></p> <ul style="list-style-type: none"> <li>• <u>2017 - now</u>: <b>Postdoctoral researcher at IAPS-INAF</b> (Rome, Italy)</li> <li>• <u>2013 - 2017</u>: <b>Support Scientist at MPIfR</b> (Bonn, Germany) <ul style="list-style-type: none"> <li>- Member of the VLBI technology division (W.Alef, A. Zensus)</li> <li>- Member of the RadioAstron Nearby and Polarisation AGN Key Science Projects</li> <li>- In charge of preparation, correlation and data quality control of 3 RadioAstron KSPs</li> </ul> </li> <li>• <u>2012 - 2013</u>: <b>Support Scientist at IRAM-Granada</b> (Granada, Spain)</li> <li>• <u>20/04/2012</u>: <b>PhD in Astronomy, Doctor Europaeus cum laude</b>  Università di Bologna (Italy) &amp; Universidad de Cantabria (Spain)  Thesis title: <i>“Origin and nature of radio-loud broad absorption line quasars: a multiwavelength study”</i></li> <li>• <u>08/04/2008</u>: <b>Master Degree in Astrophysics and Cosmic Physics</b>  Università degli Studi di Torino (Italy)  Thesis title: <i>“Revelation of Gamma-Ray Sources with ARGO-YBJ”</i>  Final mark: 110/110</li> </ul> <p><b>FELLOWSHIPS, AWARDS AND GRANTS</b></p> <ul style="list-style-type: none"> <li>• Short-term scientific mission (mobility grant) from the COST action MP1104-Polarisation as a tool to study the Solar System and beyond, to work 1 week as visiting researcher at the Instituto de Astrofísica de Andalucía (IAA, Granada, Spain) during March 2015</li> <li>• Short-term scientific mission (mobility grant) from the COST action MP0905-Black holes in a violent Universe, to work 3 weeks as visiting researcher at the Instituto de Física de Cantabria (IFCA, Santander, Spain) during May 2013</li> <li>• Research Fellowship at IRA-INAF titled “Osservazioni radio di quasar con larghe righe di assorbimento”, from 02/2012 to 04/2012</li> <li>• “Marco Polo” mobility grant from Università di Bologna to work 3 months at the Instituto de Física de Cantabria (IFCA, Santander, Spain) from October 2011 to December 2011</li> <li>• “Marco Polo” mobility grant from Università di Bologna to work 6 months at the Instituto de Física de Cantabria (IFCA, Santander, Spain) from September 2010 to February 2011</li> <li>• “Homo Sapiens” Fellowship from the Region of Piemonte for PhD studies (2010, 2011)</li> <li>• Research Fellowship at IRA-INAF supported by a grant of the Italian Programme for Research of Relevant National Interest (from 04/2009 to 06/2010, PRIN No 18/2007, PI: K.-H. Mack)</li> </ul> <p><b>THREE MOST IMPORTANT PUBLICATIONS</b></p> <ul style="list-style-type: none"> <li>• <i>Radio spectra and polarization properties of a bright sample of radio-loud broad absorption line quasars</i>, G. Bruni, K.-H. Mack, E. Salerno et al. 2012, A&amp;A, 542, A13.</li> <li>• <i>The pc-scale structure of radio-loud broad absorption line quasars</i>, G. Bruni, K.-H. Mack, D. Dallacasa et al. 2013, A&amp;A, 554, A94.</li> <li>• <i>Probing the innermost regions of AGN jets and their magnetic fields with RadioAstron. I. Imaging BL Lacertae at 21 microarcsecond resolution</i>, J. L. Gómez, A. P. Lobanov, G. Bruni et al. 2016, ApJ, 817, 96.</li> </ul>



Bologna, 1 July 2017

TO WHOM IT MAY CONCERN

Dear Dr. Bruni,

I am pleased to invite you to spend two weeks at the Istituto di Radioastronomia, Bologna, to progress with your ongoing collaborators at our institute on the project *Giant Radio Galaxies: clues of their origin from INTEGRAL detections*. Your visit will be extremely helpful to plan future work and follow-up studies with the European VLBI Network.

We suggest that you visit Bologna in the week 6-17 November 2017.

Looking forward to having you here, I send my best regards,

Tiziana Venturi  
Director of the Istituto di Radioastronomia, INAF

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