



Report from the event supported by RadioNet

TITLE *IAU SYMPOSIUM 342 – PERSEUS IN SICILY: FROM BLACK HOLE TO CLUSTER OUTSKIRTS*

DATE: *13-18 MAY 2018*

LOCATION: *NOTO, ITALY*

MEETING WEBPAGE: *<http://www.ira.inaf.it/iaus342/>*

HOST INSTITUTE: *INAF ISTITUTO DI RADIOASTRONOMIA*

**RADIONET
BENEFICIARY / NO:** *INAF / 4*

Report:

1. SCIENTIFIC SUMMARY

As intended, the symposium has seen a broad participation in several domains, with science highlights ranging across several wavelengths and spatial scales, and including observations, interpretation, numerical simulations and pure theory. A recurring quote was that “Perseus is weird”, although it eventually remained open to debate whether this weirdness were intrinsic or rather the consequence of an unparalleled level of detail that we have gathered for this system.

On the finest linear scales, approaching the event horizon scales, the main novelty has been the discovery of a wide and collimated radio jet in 3C 84 on the scale of a few hundred gravitational radii, thanks to new space very-long-baseline-interferometry observations including the RadioAstron satellite. This finding has important implications on the formation of relativistic jets in active galactic nuclei, as discussed in a series of sessions devoted to general relativity magneto-hydrodynamic numerical simulations and to the technical and computational development required by the operations of the Event Horizon Telescope.

The (sub-)parsec scale properties have also been relevant for the connection to the high and very high energy (VHE) gamma-ray emission. 3C 84 is reaching record level emission among just a handful of radio galaxies detected in gamma rays. The time scales and the spectral properties have been debated in order to constrain the location and the physical properties of the jet region responsible for the gamma-ray emission. Another Perseus galaxy, IC 310, has been reported to have very short time scale activity at VHE, which can only be explained with phenomena occurring on the black hole magnetosphere linear scale.

On somewhat larger scales, starting from a few tens of kiloparsecs, amazing images in terms of resolution and dynamic range have been presented, probing the non-thermal emission in the Perseus cluster. Spanning several wavelengths, these observations reveal a multitude of new structures extending to hundreds of kpc in size. Their irregular morphology seems to have been influenced both by the AGN activity and by the sloshing motion of the cluster’s gas. The gas properties have been the subject of X-ray focused talks, with exquisite energy and space resolution by Hitomi and Chandra, respectively. The former, in particular, has revealed a mostly uniform and low velocity dispersion.

How the AGN influences the host galaxy and the surrounding environment was also the subject of much debate, with discussions on the role of outflows, winds, and filaments both based on recent X-ray and sub-millimetre observations and on numerical simulations.

In terms of future breakthrough, it has been important to hear about projects such as the X-ray observatory Athena, the Square Kilometre Array radio telescope, and the VHE Cherenkov Telescope Array, which will provide a transformational contribution to the above areas, besides many other topics. They shall eventually reveal whether “Perseus is weird” or if many more system present similar peculiarities. We also had a look at the recent past, with a rich, brilliant, and moving talk about the legacy of Ger de Bruyn for the study of the Perseus system, of galaxy clusters in general, and ultimately the passion for astrophysical research.

In general, a significant fraction of the observations discussed in the symposium were obtained through facilities directly sponsored by RadioNet and of which the RadioNet community is user. The strong interplay with participants from other communities, and the poster and slides regularly displayed, have certainly helped advertising the RadioNet resources and goals.

The symposium web site is available at <http://www.ira.inaf.it/iaus342/>.

2. AGENDA OF THE EVENT

Monday, May 14 – Teatro Comunale

	<i>Welcome speeches</i>
<i>Session 1 – Black Hole masses. Chair: Geoffrey Bower</i>	
<i>Karl Gebhardt</i>	<i>Measurements of masses in supermassive black holes</i>
<i>Eleonora Sani</i>	<i>NGC 1275: An Outlier of the Black Hole-Host Scaling Relations</i>
<i>Luka Popovic</i>	<i>Black hole mass measurements in AGN: Polarization in broad emission lines</i>

	<i>Coffee break</i>
<i>Session 2 – Black Hole vicinity – theory and simulations. Chair: Sasha Tchekovskoy</i>	
<i>Monika Moscibrodzka</i>	<i>Black Hole Accretion in Low Luminosity Active Galactic Nuclei</i>
<i>Yosuke Mizuno</i>	<i>Testing Theories of Gravity via BH Shadows and Modeling of Relativistic Jets</i>
<i>luca ciotti</i>	<i>Fully analytical solutions for Bondi accretion in galaxies with a central black hole</i>
<i>Ziri Younsi</i>	<i>Modelling the polarised emission from black holes on event horizon-scales</i>
<i>Elisabete de Gouveia Dal Pino</i>	<i>Particle acceleration and the origin of the very high energy emission around black holes and relativistic jets</i>
	<i>Lunch</i>
<i>Session 3 – Black Hole vicinity – observations. Chair: Denise Gabuzda</i>	
<i>Kazunori Akiyama</i>	<i>Imaging and Filming Black Holes with the Event Horizon Telescope</i>
<i>Geoffrey Bower</i>	<i>Probes of Accretion and Outflow in Low Luminosity AGN Using Millimeter Polarimetry</i>
<i>Jongho Park</i>	<i>Substantial winds from hot accretion flows confining the relativistic jet of M87</i>
<i>Fabio Bacchini</i>	<i>Numerical methods for particle and ray tracing in general relativity</i>
<i>Freek Roelofs</i>	<i>On the Prospects of Imaging Sagittarius A* from Space</i>
	<i>Coffee break</i>
<i>Session 4 – Past and future legacy. Chair: Christine Jones</i>	
<i>Michiel Brentjens</i>	<i>Ger de Bruyn legacy work on the Perseus cluster</i>
<i>Melanie Johnston-Hollitt</i>	<i>Observations of clusters and AGNs with the SKA</i>
<i>Matteo Guainazzi</i>	<i>The Hot Universe with XARM and Athena</i>
<i>Elina Lindfors</i>	<i>Observations of AGNs and the Cluster in Perseus with the Cherenkov Telescope Array</i>
	<i>Outreach event: Theatre play by “Il cuore di Argante”</i>

Tuesday, May 15 – Grand Hotel Sofia

<i>Session 5 – Radio observations of Perseus & clusters. Chair: Melanie Johnston-Hollitt</i>	
<i>Ruta Kale</i>	<i>Low frequency observations of radio relics and halos: windows to the non-thermal phenomena</i>
<i>Marie-lou Gendron-Marsolais</i>	<i>Probing the non-thermal emission in Abell 2146 and the Perseus cluster with the JVLA</i>
<i>Chat Hull</i>	<i>High-dynamic-range 21 cm JVLA observations of the Perseus Cluster</i>
	<i>Coffee break</i>
<i>Session 6 – VLBI observations of 3C 84. Chair: Hiroshi Nagai</i>	
<i>Gabriele Giovannini</i>	<i>Radioastron observations of the jet launch region in 3C84</i>
<i>Tuomas Savolainen</i>	<i>Mini-cocoon around the parsec-scale jet in 3C84</i>
<i>Junghwan Oh</i>	<i>Double nuclear structure discovered in 3C84</i>
<i>Jeffrey Hodgson</i>	<i>3C 84 and a solution to the “Doppler crisis”?</i>
	<i>Lunch</i>
<i>Session 7 – 3C 84 and the radio-gamma connection. Chair: Rodrigo Nemmen</i>	
<i>Monica Orienti</i>	<i>On the radio and gamma-rays connection in extragalactic relativistic jets</i>
<i>Alastair Edge</i>	<i>The AGN activity of NGC1275 and the ubiquity of AGN in cool core BCGs</i>
<i>Hiroshi Nagai</i>	<i>Inflow and Outflow in NGC1275</i>
<i>Kazuhiro Hada</i>	<i>Observations of nearby relativistic jets with EAVN and EATING VLBI</i>
<i>Bong Won Sohn</i>	<i>EATING VLBI observations of 3C84, Mrk501 and TXS 0506+056</i>
	<i>Coffee break</i>
<i>Session 8 – Outflows and feedback (1). Chair: Elisabete de Gouveia dal Pino</i>	
<i>Francoise Combes</i>	<i>Molecular gas filamentary structures in galaxy clusters</i>
<i>Raffaella Morganti</i>	<i>Young radio jets breaking free: tracing molecular and HI fast outflows in the central</i>

	<i>regions</i>
<i>Francesco Massaro</i>	<i>Deciphering the large-scale environment of radio galaxies in the local Universe: where do they born, grow and die</i>
	<i>Tour of the city</i>

Wednesday, May 16 – Grand Hotel Sofia

<i>Session 9 – Outflows and feedback (2). Chair: Raffaella Morganti</i>	
<i>Anna Lia Longinotti</i>	<i>Ultra fast outflows, and their connection to accretion and ejection processes in AGNs</i>
<i>Silvia Pellegrini</i>	<i>AGN feedback and the origin and fate of the hot gas in early-type galaxies</i>
<i>Kiran Lakhchaura</i>	<i>Cold gas in giant elliptical galaxies</i>
<i>Yuan Li</i>	<i>The Effects of Ram Pressure on the Cold Clouds in the Centers of Galaxy Clusters</i>
<i>Feng Yuan</i>	<i>Numerical study of AGN feedback in an isolated elliptical galaxy</i>
	<i>Coffee break</i>
<i>Session 10 – Outflows and feedback (3). Chair: Feng Yuan</i>	
<i>Debora Sijacki</i>	<i>AGN feedback: from $z \sim 6$ protoclusters to massive galaxy clusters in the local Universe</i>
<i>William Eduardo Clavijo Bohórquez</i>	<i>AGN and Star Formation Feedback in Active Galaxies</i>
<i>jeremy lim</i>	<i>Prodigious and Continuous Formation of Super Star Clusters from Cooled Intracluster Gas</i>
<i>Rukmani Vijayaraghavan</i>	<i>The Physics of Galaxy Transformation during Cluster Assembly: Clues from the Perseus Cluster</i>
<i>William Forman</i>	<i>Characterizing the Outburst of the Supermassive Black Hole in M87</i>
	<i>Poster presentations. Chair: Monika Moscibrodzka</i>
	<i>Lunch</i>
	<i>Excursion and social dinner</i>

Thursday, May 17 – Grand Hotel Sofia

<i>Session 11 – X-ray observations of 3C84 & AGNs. Chair: Francesco Massaro</i>	
<i>Christopher Reynolds</i>	<i>An X-ray view of the active galactic nucleus in NGC1275</i>
<i>Yasushi Fukazawa</i>	<i>X-ray probing of NGC 1275 nuclear region with Hitomi, Swift, and Suzaku</i>
<i>Francesca Panessa</i>	<i>Jets and outflows in AGN: a radio and X-ray view</i>
<i>Vijay Mahatma</i>	<i>Probing the dynamics and energetics of radio galaxies</i>
	<i>Coffee break</i>
<i>Session 12 – X-ray observations of Perseus & clusters. Chair: Eugene Churazov</i>	
<i>Jeremy Sanders</i>	<i>The deep Chandra view of the core of the Perseus cluster</i>
<i>Takayuki Tamura</i>	<i>High energy resolution X-ray spectroscopy of the Perseus core with Hitomi</i>
<i>Natalia Lyskova</i>	<i>Close-up view of an ongoing merger between the NGC 4839 group and the Coma cluster</i>
<i>Alessandro Ignesti</i>	<i>Thermal – non-thermal connection in radio mini halos.</i>
	<i>Lunch</i>
<i>Session 13 – Galaxy cluster dynamics and energetics. Chair: Irina Zhuravleva</i>	
<i>Eugene Churazov</i>	<i>Gas structure and dynamics in galaxy clusters</i>
<i>Kristian Ehlert</i>	<i>Dynamics of AGN bubbles and cosmic rays in cool core clusters</i>
<i>Michele Doro</i>	<i>Constraints to dark matter lifetime with deep observations of Perseus with the MAGIC telescopes</i>
<i>Elias Koulouridis</i>	<i>The XXL survey: The role of cluster mass in AGN activity</i>
	<i>Coffee break</i>

<i>Session 14 – The AGN-cluster interaction in Perseus. Chair: Francoise Combes</i>	
<i>Irina Zhuravleva</i>	<i>AGN-driven Perturbations in the Hot Gas in the Perseus Cluster</i>
<i>Martin Bourne</i>	<i>Moving mesh simulation of jet feedback in galaxy clusters</i>
<i>Yi-Hao Chen</i>	<i>Feedback in the Perseus Cluster: Magnetized Jets, Bubbles, and Heat Pumps</i>
<i>Congyao Zhang</i>	<i>Generation of Internal Waves by Buoyant Bubbles in Galaxy Clusters and Heating of Intracluster Medium</i>
<i>Paramita Barai</i>	<i>Intermediate-Mass Black Hole Feedback in Dwarf Galaxies: a View from Cosmological Simulations</i>
	<i>Visit and dinner at the radio telescope</i>

Friday, May 18 – Grand Hotel Sofia

<i>Session 15 – Gamma-ray observations of 3C 84 & AGNs (1). Chair: Paola Grandi</i>	
<i>Eleonora Torresi</i>	<i>Gamma-ray emission in radio galaxies, from MeV to TeV</i>
<i>Rodrigo Nemmen</i>	<i>Searching for QPOs in the gamma-ray emission of NGC 1275</i>
<i>Narek Sahakyan</i>	<i>Rapid Gamma-Ray Variability of NGC 1275</i>
<i>Giulia Migliori</i>	<i>Young radio sources in gamma-rays: 3C 84 and PKS 1718-649</i>
	<i>Coffee break</i>
<i>Session 16 – Gamma-ray observations of 3C 84 & AGNs (2). Chair: Monica Orienti</i>	
<i>Rocco Lico</i>	<i>Exploring the the radio and GeV-TeV gamma-ray connection in the different blazar sub-classes</i>
<i>Dorit Glawion</i>	<i>IC 310: Lightning from the Black Hole?</i>
<i>Juan Carlos Rodriguez Ramirez</i>	<i>Very High Energy and Neutrino Emission from NGC1275 and IC310: GRMHD Simulations of Magnetic Reconnection and Radiative Transfer/Particle Calculations.</i>
	<i>Lunch</i>
<i>Session 17 – Magnetic fields and relativistic jets. Chair: Keiichi Asada</i>	
<i>Denise Gabuzda</i>	<i>Magnetic fields in relativistic jets</i>
<i>Elena Nokhrina</i>	<i>The correlation between magnetic flux and jet power</i>
<i>Andrzej Zdziarski</i>	<i>What is the power of jets?</i>
<i>Xinwu Cao</i>	<i>Why only a small fraction of quasars are radio loud?</i>
	<i>Coffee break</i>
<i>Session 18 – Simulations of jets and winds. Chair: Gabriele Giovannini</i>	
<i>Alexander Tchekhovskoy</i>	<i>Black hole accretion and relativistic jets</i>
<i>Sergey Bogovalov</i>	<i>Ratio of kinetic-to-bolometric luminosity at the “cold” disk accretion onto black holes</i>
<i>Izak van der Westhuizen</i>	<i>Monte-Carlo emission modelling of hydrodynamic AGN jet simulations</i>
<i>Bhargav Vaidya</i>	<i>Hybrid Framework for modelling non-thermal emission and particle acceleration from magnetised relativistic flows.</i>
<i>Defu Bu</i>	<i>Wind production from central black hole accretion flow and region beyond AGNs</i>
	<i>Concluding remarks</i>

3. PARTICIPANTS

- *The meeting was attended by 116 participants (44 females and 72 males) from 28 countries representing all six continents. The age distribution was also quite broad, from undergraduate students attending their first conference to retired scientists trying to remain updated in the field and contributing their expertise to the discussion. Of course, the bulk of the participants were staff members and post-docs. The age, geography (22 speakers from 13 countries) and gender (12*

females and 10 males) distribution of the invited speakers were also broad and well representative, also of the different science expertise.



4. RADIONET FINANCIAL CONTRIBUTION

- *The financial support from RadioNet (5500 EUR) was used to meet part of the organization costs with the goal of supporting and facilitating the attendance of participants, in particular from less privileged countries; we note that this was an IAU Symposium, therefore it raised interest in many different regions, as shown by the participant list geographical distribution, including countries where researchers are less able to travel; the IAU itself allocated a substantial amount of money to directly fund travel grants for these participants; however, the IAU grants are meant to be seed money facilitating the participation of the selected beneficiary and cannot guarantee per se the participation of less privileged researchers. The RadioNet funds were thus fundamental to allow us to keep the local expenses as low as possible, including lunches and three dinners in the registration fee, in addition to all coffee breaks, shuttle transportation between the airport and the conference venue, a conference package, a copy of the proceedings in electronic format, and a rich social and cultural program.*

5. PUBLICATIONS

- *The proceedings of the symposium will be published in the International Astronomical Union Proceedings Series by Cambridge University Press, likely in late 2018. At the moment of writing this report we can not have more precise information. We will insert the acknowledgment of the RadioNet support in the volume.*