INAF 3 Projects
PhD Cycle 37

INAF3 – Project 1
Observations of Fast Radio Bursts with the Northern Cross
Supervisor: Dr. Gianni Bernardi, Dr. Maura Pilia (gianni.bernardi@inaf.it, maura.pilia@inaf.it)

INAF3 – Project 2
Physics of non-thermal components in galaxy clusters and the LOFAR revolution
Supervisor: Dr. Gianfranco Brunetti (brunetti@ira.inaf.it)

INAF3 – Project 3
The role of relativistic jets in the assembly of the first supermassive black holes: a multi-band approach
Supervisor: Dr. Marcello Giroletti (marcello.giroletti@inaf.it)

INAF3 – Project 4
VLBI and time measurement: how radio astronomy and metrology can benefit from the use of Time and Frequency reference signals generated by national metrological institutes and provided to radio astronomy and geodesy observatories.
Supervisor: Dr. Monia Negusini, Federico Perini (monia.negusini@inaf.it, federico.perini@inaf.it)

INAF3 – Project 5
Searching for water on Mars: global mapping of the dielectric properties at the base of the Martian polar caps
Supervisor: Dr. Roberto Orosei (roberto.orosei@inaf.it)

INAF3 – Project 6
Development of techniques and tools for the image processing of radar signals for the observation of planetary bodies: from the subsurface of Mars to asteroids
Supervisor: Dr. Roberto Orosei (roberto.orosei@inaf.it)

INAF3 – Project 7
Study of magnetic field in Galaxies from dust polarized emission
Supervisor: Dr. Rosita Paladino (rosita.paladino@inaf.it)

INAF3 – Project 8
Exploiting deep radio surveys to assess the growth of black holes and the role of jet-induced AGN feedback in galaxy evolution
Supervisor: Dr. Isabella Prandoni (prandoni@ira.inaf.it)

INAF3 – Project 9
"Solar Physics and Space Weather with the Medicina 32-m Radio Telescope: Development, Test and Scientific Exploitation of a Spectro-Polarimetric Imaging System for Solar Radio Astronomy"
Supervisor: Dr. Simona Righini, Alberto Paolo Pellizzoni (simona.righini@inaf.it, alberto.pellizzoni@inaf.it)

INAF3 – Project 1

Observations of Fast Radio Bursts with the Northern Cross

Supervisor: Dr. Gianni Bernardi, Dr. Maura Pilia **(**gianni.bernardi@inaf.it, maura.pilia@inaf.it)

PhD project in ASTROPHYSICS

Title of the Project: *Observations of Fast Radio Bursts with the Northern Cross*

Supervisor: Dr. Gianni Bernardi, Dr. Maura Pilia

Scientific Case: Fast Radio Bursts (FRBs) are one of the most recent mysteries of our Universe: enigmatic, bright, ms-long bursts only observable at radio wavelengths (so far). Discovered 15 years ago, their extragalactic nature has now been well established, with a handful of them being localized in host galaxies with fairly different characteristics. They are believed to be associated with energetic phenomena (i.e. endpoints of stellar evolution, mergers of compact objects), but their real nature is still largely unknown. Recently an FRB has been associated with the Galactic magnetar SGR1935+2154, suggesting that magnetars may be progenitors of (at least some) FRBs. Observations of larger samples are needed to understand the FRB phenomenon.

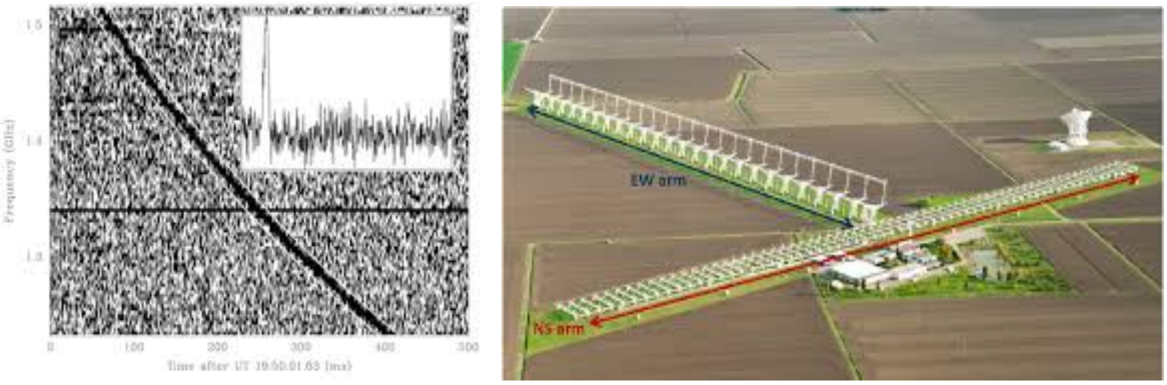

Figure 1. Left: the first FRB observed (Lorimer et al., 2007). The characteristic signature of FRBs is the dispersed profile (the black curve in the waterfall plot), i.e., the signal is delayed as it propagates through the interstellar medium, with lower frequencies arriving later than higher frequencies. Right: aerial view of the Northern Cross telescope.

Outline of the Project:

In the last two years, the Northern Cross (NC) radio telescope at the Medicina station near Bologna has been outfitted to carry out FRB surveys at 408 MHz. The NC is the first-built Italian radio telescope, and it is now competing on the international scene to help solve the FRB mystery.
In their PhD project, the candidate will analyse observations taken with the NC in order to detect FRBs, study their physical properties and constrain their formation model. In particular the candidate will be involved in two projects:

- NC observations of repeating FRBs. A fraction of FRBs are repeating sources, indicating that their progenitors may reside in binary systems. The candidate will help carrying out observations, will analyse and use them to constrain FRB models;
- NC observations of the Virgo clusters. Some models relate the FRB cosmological evolution with the cosmic star formation rate. The Virgo cluster has a well measured star formation rate that is used to predict the FRB event rate (e.g., Fialkov et al., 2018) and our group is currently surveying it. The candidate will

help carrying out observations and analyse them in order to constrain models of cosmological evolution of FRBs;

This project will lead the candidate to shed light on the FRB mystery and offer the chance to develop cutting edge data analysis pipelines, including machine learning algorithms to detect and classify FRBs.

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INAF3 – Project 2

Physics of non-thermal components in galaxy clusters and the LOFAR revolution

Supervisor: Dr. Gianfranco Brunetti (brunetti@ira.inaf.it)

PhD project in ASTROPHYSICS

Title of the Project: Physics of non-thermal components in galaxy clusters and the LOFAR revolution

Supervisor: G. Brunetti

Scientific Case: Galaxy clusters emit diffuse steep-spectrum synchrotron radiation due to relativistic electrons interacting with magnetic fields in their volume. This evidence poses important questions on the origin of non-thermal components and on their interplay with the thermal matter. In the last decade, we demonstrated a connection between the radio emission and the dynamics of galaxy clusters, suggesting that a fraction of the kinetic energy of dark-matter and baryons is channeled into magnetic fields and high energy particles. Mechanisms responsible for powering the non-thermal components involve turbulence and shocks operating in physical regimes that are still poorly explored. Thanks to its unprecedented sensitivity at low frequencies, LOFAR is achieving a breakthrough in the field, allowing us straightforward tests of theories and pushing studies into a completely new regime.

Outline of the Project: We propose two lines for a PhD project which combine data analysis and theoretical interpretation:

1. Formation rate of radio halos in galaxy clusters at different cosmic epochs
LOFAR surveys (LoTSS, LoLSS) are expected to detect about 1000 galaxy clusters extending the limited ranges of masses, redshifts and statistics, that are severely limiting present studies. Data from 5700 square degrees (DR2 area, 27% of the northern sky) are already available to our group. We plan to analyze the data of the 309 clusters of the PSZ2 catalog that are in this LoTSS-DR2 area to obtain unprecedented information on the statistical properties of diffuse emission in clusters. Importantly, we will investigate the occurrence of radio halos in an unexplored range of clusters masses and redshifts (up to z=1), obtaining fundamental constraints on the magnetic field amplification and particle acceleration, and testing current models.
Coll : R. Cassano, D. Dallacasa, A. Bonafede

2. Superclusters and radio bridges
LOFAR observations have discovered steep-spectrum diffuse radio emission from bridges of matter that connect pairs of massive clusters in a pre-merger phase. These radio bridges presumably trace dynamically active and vast filaments connecting massive clusters where turbulence amplify magnetic fields and accelerate relativistic particles. A statistical assessment of the occurrence of radio bridges and a firm measure of their radio spectrum is possible only with LoTSS and LoLSS data. During the project we plan to exploit the vast wealth of the available LOFAR data to step into this very new territory and to carry out a comparison with current models.
As a further step we plan to search for diffuse radio emission from super-clusters. Detection of radio emission on super-clusters scales would provide important information on the heating mechanisms in the large scale structures and in particular on the physics of turbulence, shocks and magnetic fields in these environments. The first target of the project will be the Corona Borealis that has been recently observed for about 70 hrs with LOFAR in the HBA band.
Coll : R. Cassano, T. Venturi, D. Dallacasa, A. Bonafede, F. Vazza

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INAF3 – Project 3

The role of relativistic jets in the assembly of the first supermassive black holes: a multi-band approach

Supervisor: Dr. Marcello Giroletti (marcello.giroletti@inaf.it)

PhD project in ASTROPHYSICS
(one page)

Title of the Project: The role of relativistic jets in the assembly of the first supermassive black holes: a multi-band approach

Supervisor: Dr. Marcello Giroletti (INAF Istituto di Radioastronomia)

Scientific Case: Little is observationally known above redshift z = 6, when the Universe was young and the first sources (including active galactic nuclei, AGN) ionised their surrounding gas in the period called cosmic reionization (e.g., Zaroubi 2013). The AGN detected at these cosmological distances have already masses higher than 10^{8-9} $M_{\odot}$ (e.g., Vito et al. 2019) which are indicative of a fast and efficient growth that challenges supermassive black holes (SMBH) standard formation models (e.g., Volonteri 2012; Wu et al. 2015). Among the high-z AGN those that are also radio-loud are about 10% of the entire AGN population (Bañados et al. 2015; Padovani et al. 2017), and provide a unique opportunity to study the role of jets in the accretion of SMBH (e.g., Volonteri et al. 2015), their feedback on the host galaxy (e.g., Fabian 2012), the cosmic evolution of the AGN radio luminosity function (Padovani et al. 2015) out to the largest distances; they can also be used as cosmological probes (e.g., Gurvits et al. 1999).
The radio-loud AGN called blazars have their relativistic jets oriented along the line of sight (Urry & Padovani 1995). Since their non-thermal radiation is relativistically amplified, and not obscured along the jet direction, blazars are very bright and visible up to high redshifts, allowing the study of the radio-loud AGN population across cosmic time (e.g., Ajello et al. 2009; Caccianiga et al. 2019). Indeed, our team has been recently involved in the discovery of the highest redshift blazar (Belladitta et al. 2020) and its follow-up at high angular resolution (Spingola et al. 2020).

Outline of the Project: The proposed PhD project will focus on confirming and characterizing the high-z blazar population by:
1) performing a multi-band analysis using state-of-the-art VLBI observations of the entire sample of blazar candidates at z>4 to constrain the actual number of high-z blazars;
2) assessing the low (150MHz) and ultra-low (50 MHz) properties for the first blazar at z>6 and the entire sample to connect the Mpc to pc-scale emission for the first time at those redshifts. LOFAR data for the first blazar are already in hand, those for the other sources will be searched for in the available deep surveys or requested with dedicated new observing proposals. The characterization of the low-frequency spectral turnover has the power to assess the physical conditions (e.g. magnetic field) and the radiative mechanisms (e.g. FFA vs SSA) in AGN up to extremely high redshifts.
3) An important domain to detect and study high-redshift blazars at high energies is the X-ray band. Hard X-ray data, available or requested in the future, will be used to study the properties of a sample of candidate and confirmed high-z blazars; new soft X-ray data from e-ROSITA will also be publicly available for the characterization of this sample.
4) The typical spectral energy distribution of high-z blazars makes their detection in gamma rays very challenging, with only a handful of blazars discovered at high-energy, which is however critical in characterizing the emission mechanisms. A research on gamma-ray emission from high redshift blazar candidates will be performed, and predictions for future missions and ground-based instruments will complete the PhD Thesis topics.

Contacts: Dr. M. Giroletti (marcello.giroletti@inaf.it), Dr. M. Orienti, Dr. F. D'Ammando, Dr. G. Migliori, Prof. D. Dallacasa

INAF3 – Project 4

VLBI and time measurement: how radio astronomy and metrology can benefit from the use of Time and Frequency reference signals generated by national metrological institutes and provided to radio astronomy and geodesy observatories.

Supervisor: Dr. Monia Negusini, Federico Perini (monia.negusini@inaf.it, federico.perini@inaf.it)

PhD project in ASTROPHYSICS
(one page)

Title of the Project: *VLBI and time measurement: how radio astronomy and metrology can benefit from the use of Time and Frequency reference signals generated by national metrological institutes and provided to radio astronomy and geodesy observatories.*

Supervisor: Monia Negusini / Federico Perini

Scientific Case: Study of the impact of providing time and frequency references based on more precise and less noisy optical clocks than current local H-masers on single dish/VLBI very high frequency observations. Metrological applications of VLBI observations, with particular regard to the possibility of performing clock comparisons on intercontinental scales, towards the redefinition of the second.

Outline of the Project: Since 2015 the Medicina Radioastronomy Station is connected to the Istituto Nazionale di Ricerca Metrologica (INRIM), where the Italian primary clocks are located, whose frequency standards are spread through a coherent fiber link (Italian Quantum Backbone, IQB). Over the years, the infrastructure has been made increasingly more robust and reliable and has been simultaneously extended to reach the ASI Space Geodesy Station in Matera in 2018. The connection between national metrological institutes (NMIs) and radio astronomy and geodetic stations opens up the possibility of new observational techniques that can benefit both scientific communities. Furthermore, since 2018 the Medicina station has hosted a 2.4 m diameter antenna designed and built by the National Institute of Information and Communications Technology (NICT) to carry out broadband VLBI measurements with the aim of comparing optical clocks on an intercontinental basis. This technique is innovative to overcome the obstacles imposed by current clock comparison techniques using satellites in terms of cost and feasibility. Thanks to the combination of the coherent optical link between INRIM and Medicina and the VLBI broadband antenna located there, it was possible to compare the Ytterbium optical clock located at INRIM in Turin with the Strontium optical clock located in Japan through VLBI experiments (Pizzocaro et al 2021). Thanks to the extension of the IQB infrastructure to Matera Space Geodesy Center, it was possible to conduct a first geodetic common-clock experiment between the two VLBI antennas of Medicina and Matera (Clivati et al. 2020). This infrastructure and the skills acquired by IRA and INRIM in recent years are enabling for future developments, both in geodesy, with the upcoming installation of a new generation geodetic antenna (VGOS) in Matera, and in the radio astronomy field, with the next installation of the Korean triple-band receiver on the VLBI INAF antennas of Medicina, Noto and SRT.
For metrology, it is important to explore the feasibility of performing VLBI observations on an intercontinental scale using broadband VGOS and VLBI antennas for the comparison of optical clocks, if the observatories are connected to NMIs. For astronomy, the possibility of verifying the impact of providing time and frequency references based on more precise and less noisy optical clocks than current local H-masers on single dish/VLBI very high frequency observations. Potentially, all the INAF antennas could be reached by the same the same reference signal (common clock), thanks to an extension of the IQB to Noto and SRT, enabling new kind of observation strategy in collaboration with the Korea VLBI Network.

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Clivati et al. (2020) "Common-clock very long baseline interferometry using a coherent optical fiber link," Optica 7, 1031-1037
Pizzocaro et al (2021) “Intercontinental comparison of optical atomic clocks via very long baseline interferometry”, Nat. Phys.. doi: 10.1038/s41567-020-01038-6.

INAF3 – Project 5

Searching for water on Mars: global mapping of the dielectric properties at the base of the Martian polar caps

Supervisor: Dr. Roberto Orosei (roberto.orosei@inaf.it)

PhD project in ASTROPHYSICS

Title of the Project: Searching for water on Mars: global mapping of the dielectric properties at the base of the Martian polar caps

Supervisor: Roberto Orosei, Istituto Nazionale di Astrofisica, Istituto di Radioastronomia

Scientific Case: After the identification of the presence of liquid water under the southern polar cap of Mars, starting from the data of the MARSIS orbital radar on board the European probe Mars Express, the quantitative analysis of the observations of this experiment in other areas of the planet has become a high-priority scientific goal. The amount of data and the need to extract information from them using semi-automatic techniques make the task challenging, but they form the basis for a complete mapping of the areas potentially containing liquid water below the Martian polar ice caps.

Outline of the Project: The development of methods for the inversion of the signal to identify the presence of water will eventually lead to a global understanding of its origin, of the mechanisms that allow its existence and of its role in constituting a possible habitat for any primitive life forms on Mars. The candidate should be interested in the study and modeling of electromagnetic propagation, in the implementation of numerical simulations and methods for radio signal analysis, and should have at least basic skills in numerical programming languages (Matlab, IDL, etc.) A knowledge of methods for statistical inference and for programming machines for parallel computing is a preferential title.

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INAF3 – Project 6

Development of techniques and tools for the image processing of radar signals for the observation of planetary bodies: from the subsurface of Mars to asteroids

Supervisor: Dr. Roberto Orosei (roberto.orosei@inaf.it)

PhD project in ASTROPHYSICS

Title of the Project: Development of techniques and tools for the image processing of radar signals for the observation of planetary bodies: from the subsurface of Mars to asteroids

Supervisor: Roberto Orosei, Istituto Nazionale di Astrofisica, Istituto di Radioastronomia

Scientific Case: Radar experiments have been used successfully in the exploration of the Solar System both from orbiting probes and from the ground. The elaboration of the acquired signal allows reconstructing images useful for the characterization and the geological study of the surfaces and the subsoil of solar system bodies. The problems to be addressed concern the correction of distortion effects caused by the ionosphere, the calibration of the data, range and azimuth processing algorithms, and the extraction of quantitative information from the images thus obtained.

Outline of the Project: The candidate will learn the basics of these techniques to develop and specialize them according to two projects active at IRA, namely the observation of the subsurface of Mars using the MARSIS radar on board the European Mars Express probe in orbit around Mars, and the feasibility study for the observation of potentially dangerous asteroids for the Earth (Near Earth Objects - NEO) using ground-based radars. This last project will end in the summer of 2021 but will be the premise for a subsequent development phase still to be planned. The candidate should be interested in the study and modeling of electromagnetic propagation, in the implementation of numerical simulations and methods for radio signal analysis, and should have at least basic skills in numerical programming languages (Matlab , IDL, etc.)

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INAF3 – Project 7

Study of magnetic field in Galaxies from dust polarized emission

Supervisor: Dr. Rosita Paladino (rosita.paladino@inaf.it)

PhD project in ASTROPHYSICS
(one page)

Title of the Project: ***Study of magnetic field in Galaxies from dust polarized emission***

Supervisor: Rosita Paladino

Scientific Case:

Mapping the structure of magnetic fields in the cold interstellar medium of galaxies is crucial to understand how magnetic fields influence gas dynamics and in particular their role in regulating star formation, driving galactic outflows and fueling galactic nuclei.
To date, magnetic field studies in external galaxies have mostly used radio synchrotron emission as a tracer of the magnetic field's strength and structure. This gives only a partial view since synchrotron emission traces mainly the hot and diffuse halo of galaxies.
The dust polarization traces instead the magnetic field in most dense and cold regions, where star formation actually happens. These measurements are crucial to understand the connection between magnetic fields and star formation processes as well as their effects on galaxy's structures (disc, spiral arms, jets, nuclei). Furthermore, dust polarization studies can help understand the physics of dust, and the different dust properties inside each galaxy and from galaxy to galaxy.

Outline of the Project:

Current new facilities, such as SOFIA and ALMA are opening a new perspective on magnetic field studies.

The proposed project will be focused on the analysis of the emission of polarized dust in nearby galaxies, already observed with SOFIA (HAWC+ data from the "Magnetic Fields in Galaxies" SOFIA Legacy programme) and ALMA (proprietary ALMA full polarization data). By comparing dust polarization and synchrotron emission in external galaxies it will be possible to build a coherent picture of magnetic fields in galactic interstellar medium.

The study will be extended to other targets, proposed for observations.

Main collaborators: Annie Hughes (IRAP-CNRS)

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INAF3 – Project 8

Exploiting deep radio surveys to assess the growth of black holes and the role of jet-induced AGN feedback in galaxy evolution

Supervisor: Dr. Isabella Prandoni (prandoni@ira.inaf.it)

PhD project in ASTROPHYSICS

Title of the Project: Exploiting deep radio surveys to assess the growth of black holes and the role of jet-induced AGN feedback in galaxy evolution

Supervisor: I. Prandoni (IRA-INAF)

Scientific Case: Understanding the evolution of galaxies, from the end of the 'dark ages' through to the complexity and variety of systems we observe in the local Universe, remains a primary goal for observational and theoretical astrophysics. A crucial piece of the evolutionary picture is the role that active galactic nuclei (AGN) play in shaping galaxies over cosmic time. Indeed, the energy released by the AGN through radiative winds and/or radio jets is widely believed to regulate the rate of star formation in their host galaxies via so-called "AGN feedback". However, the details of how and when this occurs remains uncertain from both an observational and theoretical perspective (e.g. see reviews by Heckman & Best 2014; Harrison 2017).

It is widely accepted that recurrent jet-mode AGN activity is a fundamental component of the lifecycle of the most massive galaxies, responsible for maintaining these as 'old, red and dead' (e.g. Best+06; Bower+06; Sabater+19). There is however mounting evidence that at least a fraction (~30%; Delvecchio+17) of radio-quiet (RQ) AGN (i.e. Seyfert galaxies and quasars) host compact AGN-triggered radio cores, possibly associated with mini-jets on (sub-)galactic scale (see also Maini+16; Herrera-Ruiz+16; Radcliffe+18). If mini-jets are a common feature (Jarvis+19), jet-driven feedback could play a significant role in shaping galaxy evolution even at lower stellar masses. These findings open new very exciting perspectives for next-generation radio-continuum surveys.

Outline of the Project: The supervisor is actively participating and has leading roles in international legacy projects involving wide-field and/or deep radio-continuum surveys of some of the most popular extra-galactic fields (GOODS-N, COSMOS, etc.), carried out with SKA pathfinders/precursors (eMERLIN, JVLA, LOFAR, MeerKAT, ASKAP, etc.). At the depths probed by these surveys the radio sky is dominated by star-forming galaxies (SFG), and RQ AGN, while powerful radio galaxies (RG) and radio-loud quasars (RL-QSO) only represent a minor contribution (e.g. Prandoni+18). These surveys hence provide a powerful dust/gas-obscuration-free tool to 1) get a complete census of AGN (including Compton-thick objects missed by X-ray surveys), and study how the Type-1/Type-2 AGN fractions evolve with both luminosity and redshift; 2) assess the incidence of mini-jets in RQ AGN populations and shed light on their role in shaping galaxies across cosmic time.

The Phd thesis project will make use of data from one or more of the following surveys:

- eMERGE with JVLA and eMERLIN (see e.g. Guidetti+17; Muxlow+20)
- MIGHTEE with MeerKAT (see e.g. Jarvis+17; Delvecchio+21)
- EMU with ASKAP (see e.g. Norris+2011)
- J1030 field with JVLA, LOFAR, ALMA (see e.g. Gilli+19; D'Amato+20; Mignoli+20)
- LoTSS Deep Fields with LOFAR (see e.g. Tasse+21; Sabater+21; Mandal+21)

which offer complementary views on faint AGN populations. Through a comparative study of RQ and low (radio) luminosity RL AGN we will be able to identify common trends and systematic differences, that will shed light on the origin of the radio emission in the radio quiet population. The study will be done by combining radio data with the deep, extensive multi-band coverage (UV/optical/IR/sub-mm/X-ray) available for these fields. A multi-frequency, multi-band approach is essential to link the radio properties (radio power, size, spectrum and morphology) to the AGN (e.g. accretion rate, duty cycle) and host galaxy properties (stellar and dust mass, star formation rate, redshift, environment, etc.). In some cases, high quality (HI or optical) spectroscopy is available, allowing us to directly explore the link between radio emission and gaseous outflows.

Depending on the student's interests and skills the focus of the thesis can vary: more weight can be given to radio or to ancillary multi-band data analysis; to theoretical or observational studies.

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INAF3 – Project 9

"Solar Physics and Space Weather with the Medicina 32-m Radio Telescope: Development, Test and Scientific Exploitation of a Spectro-Polarimetric Imaging System for Solar Radio Astronomy"

Supervisor: Dr. Simona Righini, Alberto Paolo Pellizzoni (simona.righini@inaf.it, alberto.pellizzoni@inaf.it)

PhD project in ASTROPHYSICS
(one page)

Title of the Project:
"Solar Physics and Space Weather with the Medicina 32-m Radio Telescope: Development, Test and Scientific Exploitation of a Spectro-Polarimetric Imaging System for Solar Radio Astronomy"

Supervisor: Simona Righini (INAF-IRA), Alberto Paolo Pellizzoni (INAF-OAC)

Scientific Case:

In the framework of the SunDish Project, a national program devoted to single-dish solar imaging with INAF Radio Telescopes, we propose a challenging Ph.D. program involving technological developments and science exploitation within an innovative and multi-disciplinary approach to Solar Physics applications. The SunDish project is devoted to radio imaging and monitoring of the solar atmosphere at high radio frequencies (at present 18-26 GHz, up to 100 GHz in perspective) through single-dish observations with the Italian radio telescopes.
Mapping the brightness temperature of the solar atmosphere in the radio band allows to reveal plasma processes, mostly originating from free-free emission in the local thermodynamic equilibrium, providing a probe of physical conditions in a wide range of atmospheric layers.
In particular, long-term diachronic radio observations of the solar disk represent an effective tool to characterise the vertical structure and physical conditions of the solar chromosphere, both for quiet and active regions, during their evolution at different phases of the solar cycle. Within this context, the Medicina 32-m and SRT 64-m radio telescopes are increasingly assessing their role in the international solar science panorama.
After a first test campaign aimed at defining and optimising solar imaging requirements for the radio telescopes, the system is ready for systematic monitoring of the Sun to provide:

1. accurate measurement of the brightness temperature of the radio-quiet Sun component, which so far has been poorly explored in the 20-26 GHz range, representing a significant constraint for atmospheric models;
2. characterization of the flux density, spectral properties and long-term evolution of dynamical features (active regions, coronal holes, loop systems, streamers and the coronal plateau);
3. prediction of powerful flares through the detection of peculiar spectral variations in the active regions, as a promising forecasting probe for the Space Weather hazard network.

A fundamental step forward in the project development will be the implementation of spectro-polarimetric capabilities at the Medicina 32-m dish (with the installation of a back-end similar to the one already in use at the SRT), placing our radio telescopes among major international facilities devoted to high-frequency radio monitoring of the Sun.

Outline of the Project:

The Ph.D. candidate will be part, through her/his involvement, in the following activities:

- test and validation of the spectro-polarimeter to be soon installed at the 32-m Medicina dish;
- execution of observations with the Medicina dish;
- development, test and optimisation of data analysis procedures;
- science exploitation of the acquired data (both using data from Medicina and SRT) in the framework of national and international collaborations/networks including both young enthusiastic researchers and affirmed experts in this field.

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