

DETECTING THE RADIO SIGNAL FROM COSMIC FILAMENTS

Supervision

The PhD project will be co-supervised by:

- Dr. Franco Vazza (University of Bologna, University of Hamburg, Principal Investigator of the ERC-funded research group MAGCOW);
- Prof. Daniele Dallacasa (University of Bologna, IRA-INAF Bologna).

Funding

This PhD project is funded by the European Research Council (ERC) Starting Grant no.714196 MAGCOW-The Magnetised Cosmic Web, active from 2017 to 2022.

Through this project, the PhD student will get additional funding resources to attend international conferences, training activities and to visit collaborators abroad.

The Scientific Case

- While the dark matter skeleton of the cosmic web is closely traced by galaxies and galaxy clusters, the gaseous distribution is mostly unobserved so far, due to the extremely weak signal from the rarefied gas at all wavelengths. The next decade promises to be a "golden epoch" for radio astronomy, due to the deployment of many revolutionary radio telescopes. While the most powerful of all, the Square Kilometer Array, should deliver first scientific results only from ~2020, a flurry of precious radio observations will be earlier delivered by the its precursors or pathfinders: LOFAR, MWA, ASKAP and MeerKat. Moreover, the augmented capabilities of the Jansky Very Large Array after the upgrade with broadband polarimetry (JVLA) will allow deep studies of Faraday Rotation/Synthesis on selected targets. These instruments might be able to detect the tip of the iceberg of the rarefied intergalactic medium. The signal is expected to be difficult to interpret. Advanced analysis techniques are being developed to overcome the challenges posed by the wide-field and multi-frequency nature of next generation of radio data.
- The detection of the radio signal from the rarefied gas in cosmic filaments will give us crucial hints about the origin of extragalactic magnetic fields, which is still unknown, as this environment is predicted to keep dynamical memory of past seeding events of magnetic fields.

Synopsis of the project

- During this PhD project the candidate will develop a unique expertise in observing and interpreting polarised radio data from intergalactic filaments. The candidate will learn the state-of-the-art in the analysis of Faraday Rotation and Faraday Synthesis of radio observations, and will apply these techniques to the study of candidate targets for the first detection of magnetic fields in cosmic filaments. The candidate will start from observations already obtained by our group at the JVLA, and later will apply these tools to the analysis of new observations obtained with new telescopes (e.g. ASKAP and MeerKat).
- The observations we already obtained with JVLA are designed to probe the Faraday Rotation down to a few rad/m^2 , which may potentially detect magnetic fields of order $\sim 0.01\text{-}0.1 \mu\text{G}$ in intergalactic filaments. The student will use dedicated tools to model the signal into a 3-dimensional distribution of magnetic fields, also using the advanced numerical resolution produced within the MAGCOW group. These results will be used to attempt constraining the amplitude of primordial magnetic fields with an unprecedented level of detail.
- Based on the results and on the expertise built during this first stage, the PhD candidate will have the chance of proposing new observations targeting filaments on the JVLA and on other radio telescopes. The access to additional interesting data from new radio telescopes (ASKAP, MeerKat) will be granted through the international collaborators of the MAGCOW group.

International Context

- The PhD candidate will have the opportunity of conducting this research in a florid research environment, closely connected with the most important international multi-band surveys of the

- next decade (with the Square Kilometer Array, Euclid, Athena, etc).
- The ERC group MAGCOW is also closely connected with the University of Hamburg (Germany), which is the second beneficiary of the grant, and this will allow the PhD candidate to work in close contact with international colleagues since the start of the project.
 - Through the collaborators of MAGCOW, the PhD candidate will also have access to data from all important radio telescopes already aiming at the detection of the cosmic web: LOFAR, MWA, ASKAP and the JVLA.

Contacts:

email: franco.vazza@hs.uni-hamburg.de - vazza@ira.inaf.it
 ddallaca@ira.inaf.it - daniele.dallacasa@unibo.it

homepage: <http://cosmosimfrazza.myfreesites.net>
<http://cosmosimfrazza.myfreesites.net/magcow>

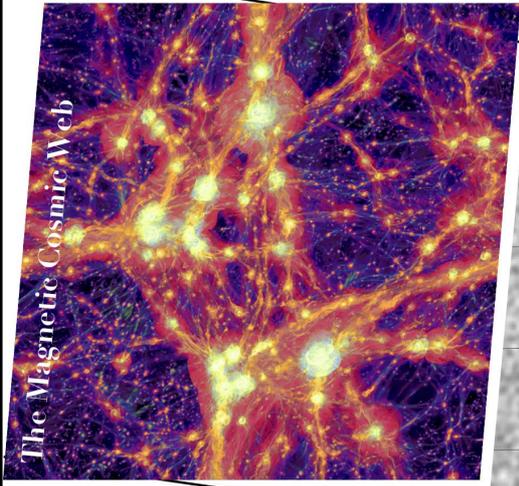


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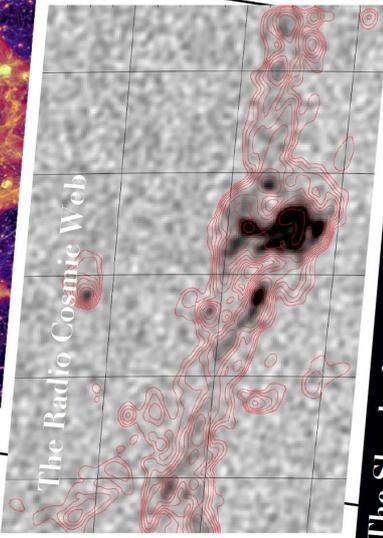


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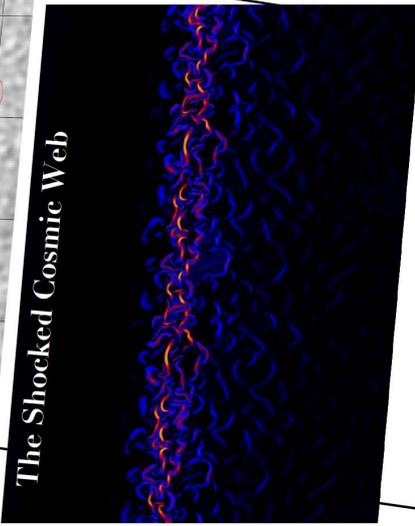


The Magnetic Cosmic Web

*What is the origin of extragalactic magnetic fields?
Can we detect the cosmic web in radio?*



The Radio Cosmic Web



The Shocked Cosmic Web



Università di Bologna
(Host Institution)



Universität Hamburg
(Secondary Host)

Principal Investigator:
Franco Vazza

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