

# Observing Filaments Between Galaxy Clusters with NenuFAR How to Probe Cosmic Magnetic Fields

NenuFAR workshop presentation

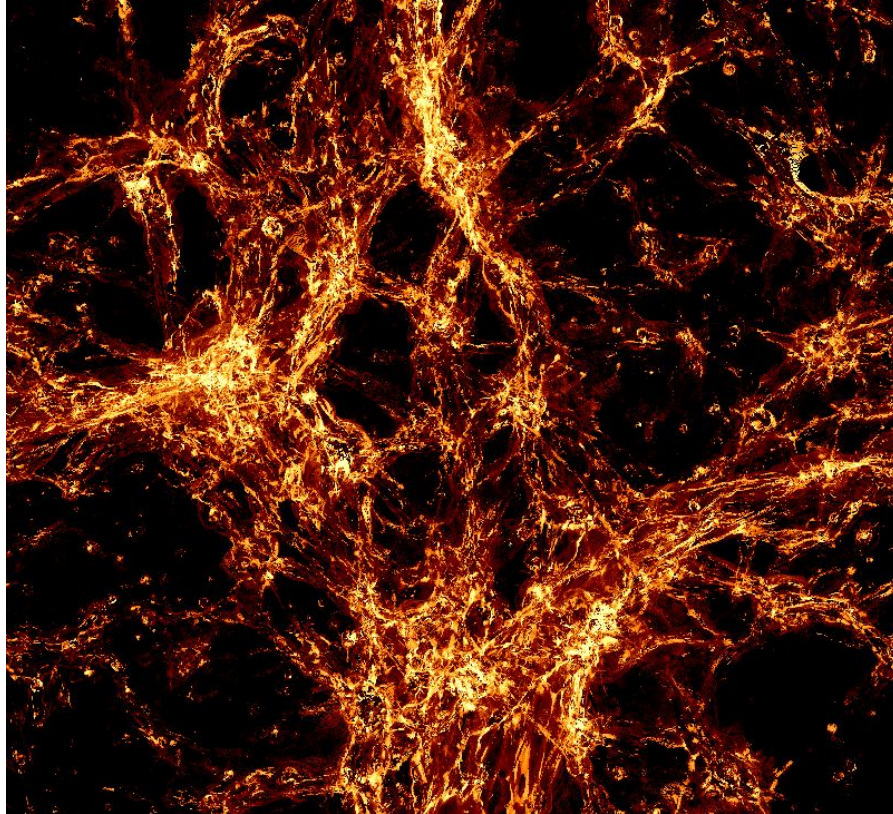
Etienne Bonnassieux, DRANOEL postdoctoral research fellow at UniBo

Collaboration with A. Bonafede, F. Vazza, C. Ferrari,  
F. de Gasperin, C. Tasse, ...

# Outline

- Science Goals
- Why NenuFAR?
- Why us?

# Galaxy filaments & Cosmic Magnetism



# Galaxy filaments & Cosmic Magnetism

To study cosmic magnetism:

- Magnetic field in clusters dominated by ICM evolution
- To understand primordial magnetic field, need to go outside clusters

BUT

- If there are no relativistic electrons to decay in a forest, what can astronomers know about its magnetic field?...

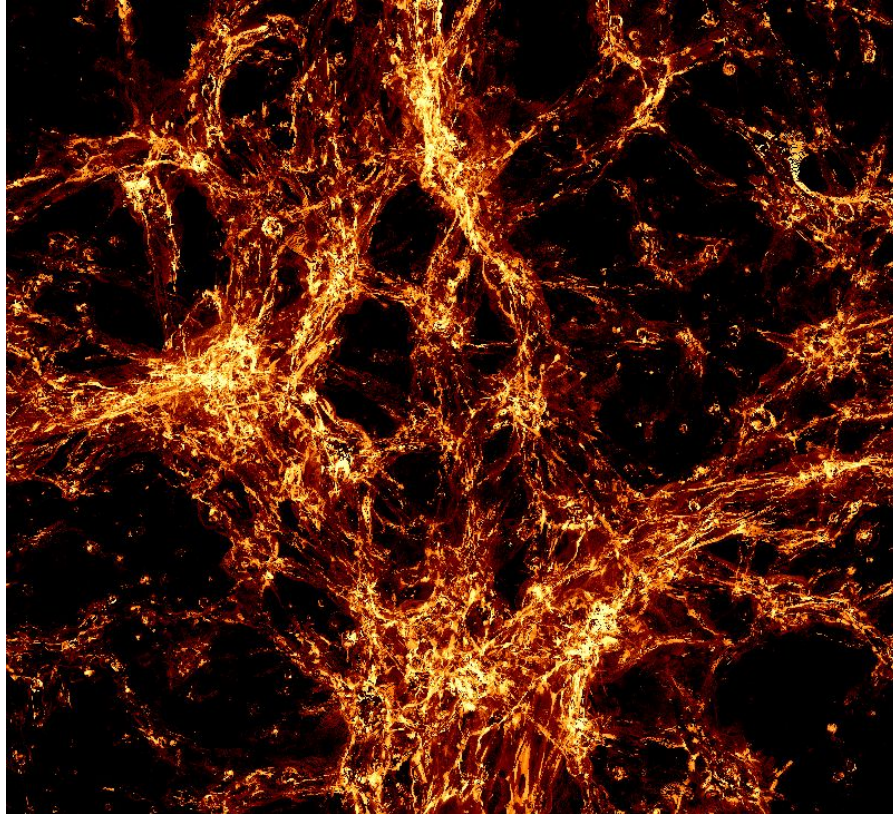
# Galaxy filaments & Cosmic Magnetism

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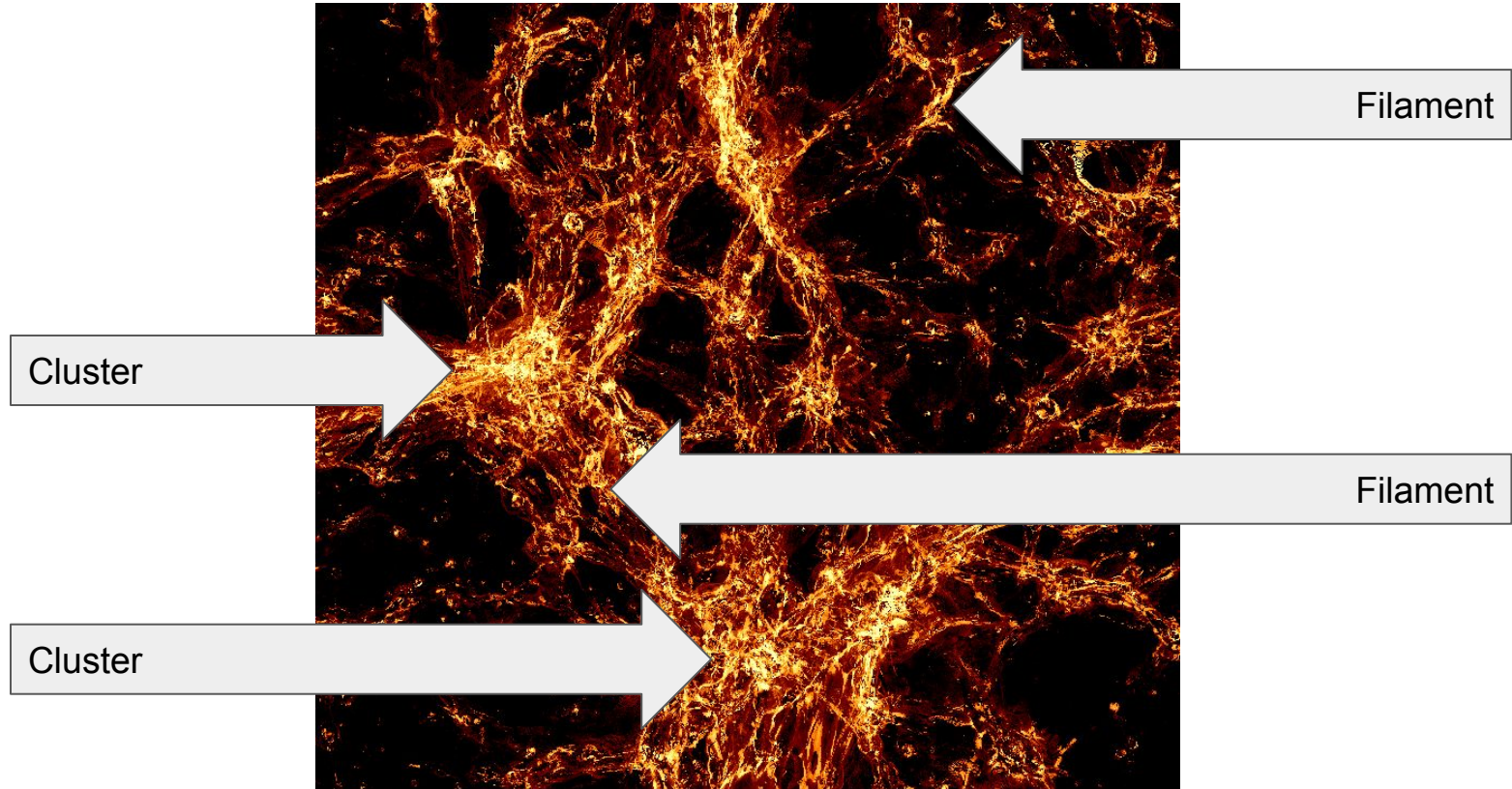
- Magnetic field in clusters dominated by ICM evolution
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**Filaments: best environment for both presence of emitting particles and unmarred cosmic magnetic field**

# Galaxy filaments & Cosmic Magnetism



# Galaxy filaments & Cosmic Magnetism



# Galaxy filaments & NenuFAR





# Galaxy filaments & NenuFAR

Observational constraints for filament observations:

- Physics of cosmic magnetism traced by large-scale, diffuse structures
- Emission mechanism of said structures more effective at lower frequencies
- Presence of foreground/embedded point sources imposes angular resolution constraints to improve confusion limits

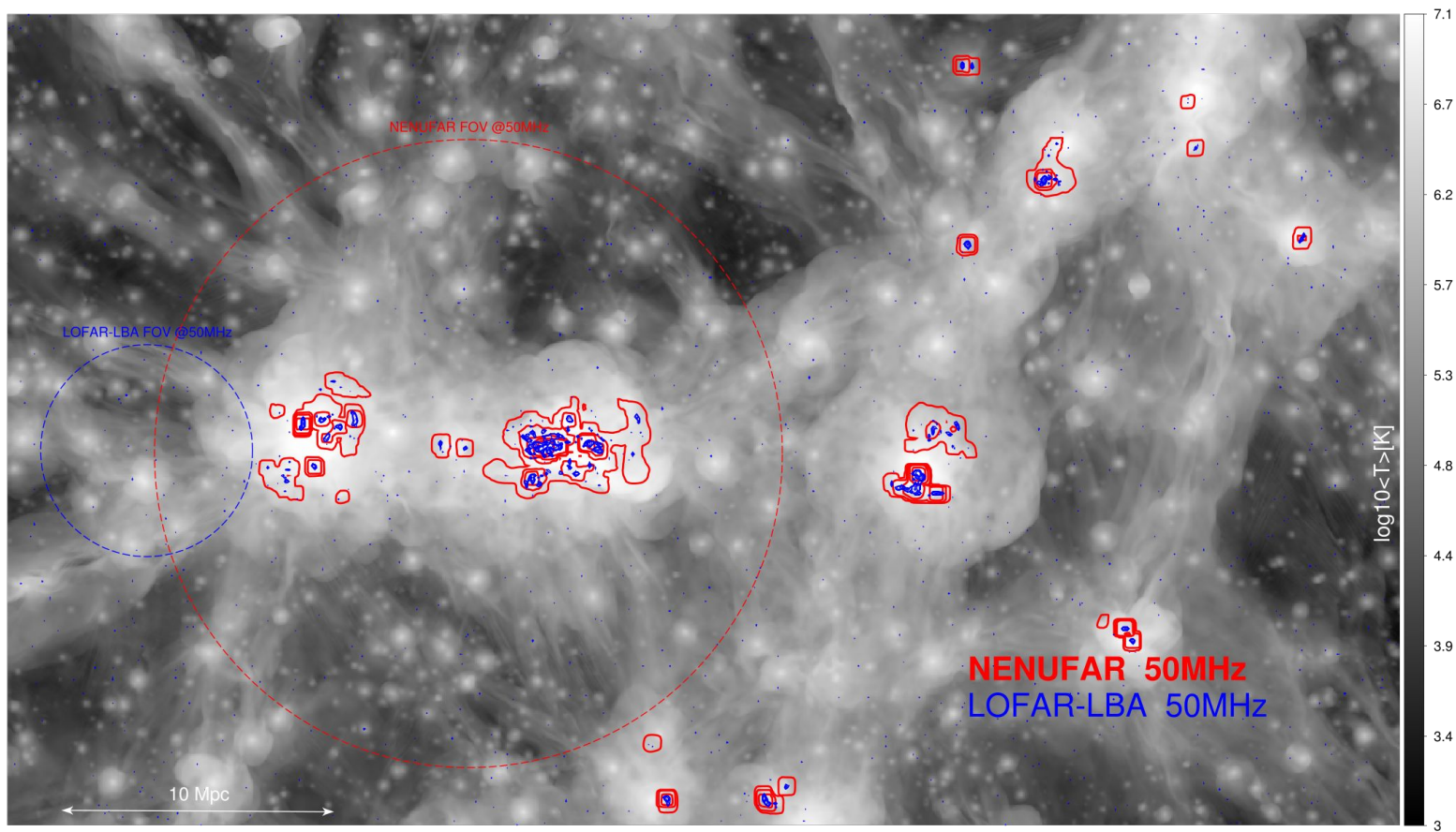
# Galaxy filaments & NenuFAR

Observational constraints for filament observations:

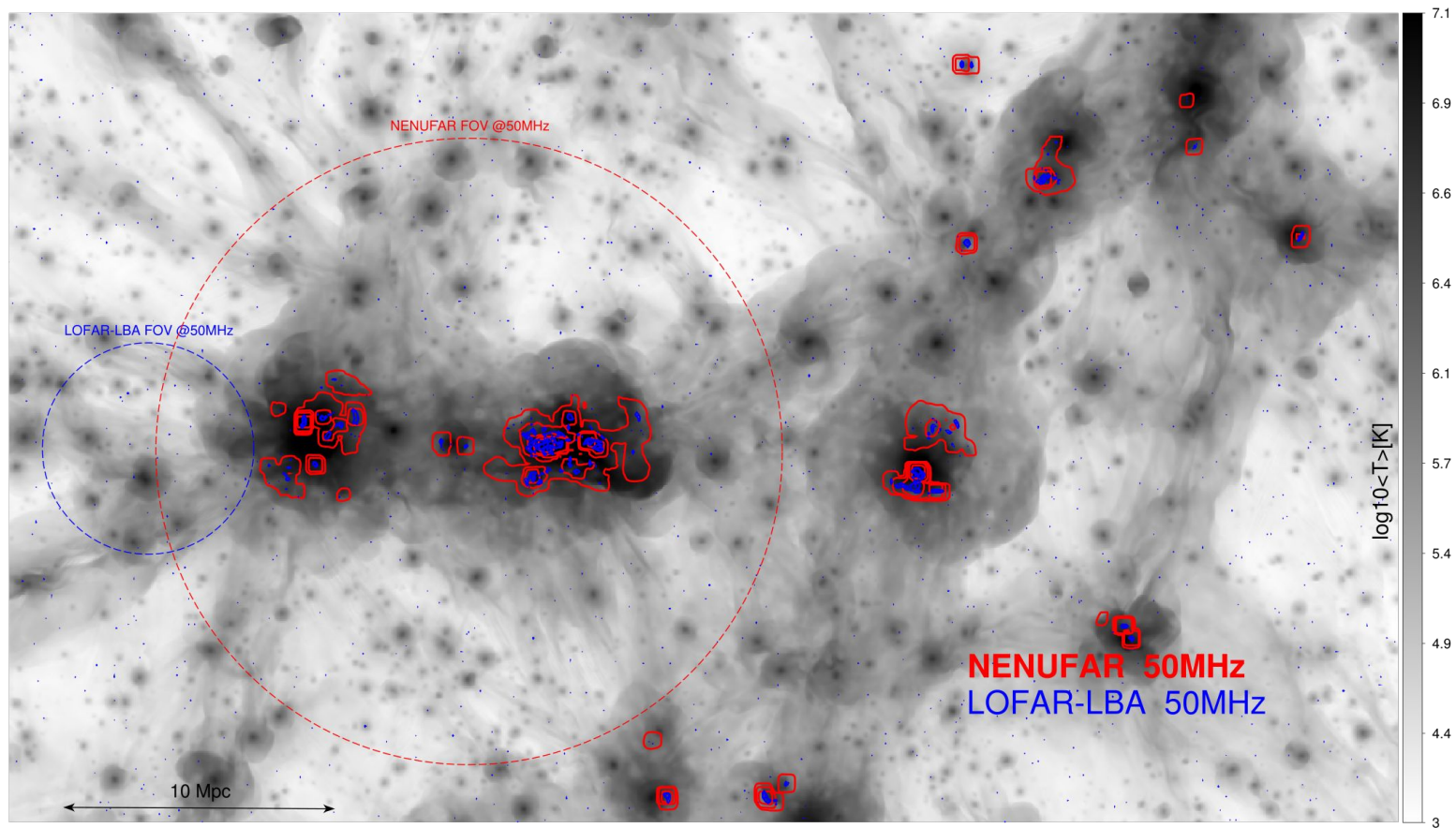
- Physics of cosmic magnetism traced by large-scale, diffuse structures
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**➡ NenuFAR standalone in imager mode + supersynthesis**

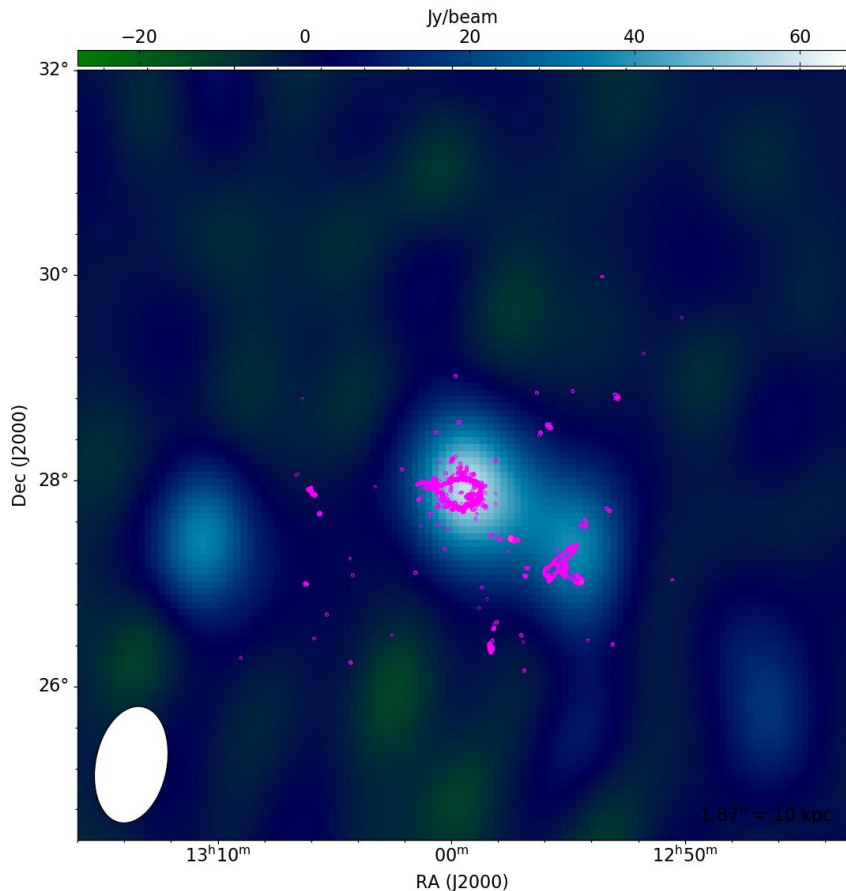
# Galaxy filaments & NenuFAR



# Galaxy filaments & NenuFAR



# Current Results



## Article

### First Lights on the Cosmic Magnetism Project with NenuFAR: the Coma Cluster field

Etienne Bonnasieur<sup>1,2</sup>, Evangelia Tremou<sup>3</sup>, Julien Girard<sup>5</sup>, Alan Loh<sup>5</sup>, Valentina Vacca<sup>4</sup>, Philippe Zarka<sup>5</sup>, Jean-Mathias Griessmeier<sup>3,6</sup>, L. ("Leon") V.E. Koopmans<sup>7</sup>, Michel Tagger<sup>5</sup>, Stephane Corbel<sup>6,8</sup>, Gilles Theureau<sup>5,6</sup>

Citation: E. Bonnasieur, E. Tremou, J. Girard, A. Loh, V. Vacca, First Lights on the Cosmic Magnetism Project with NenuFAR: the Coma Cluster field. *Galaxies* 2021, 1, 0. <https://doi.org/>

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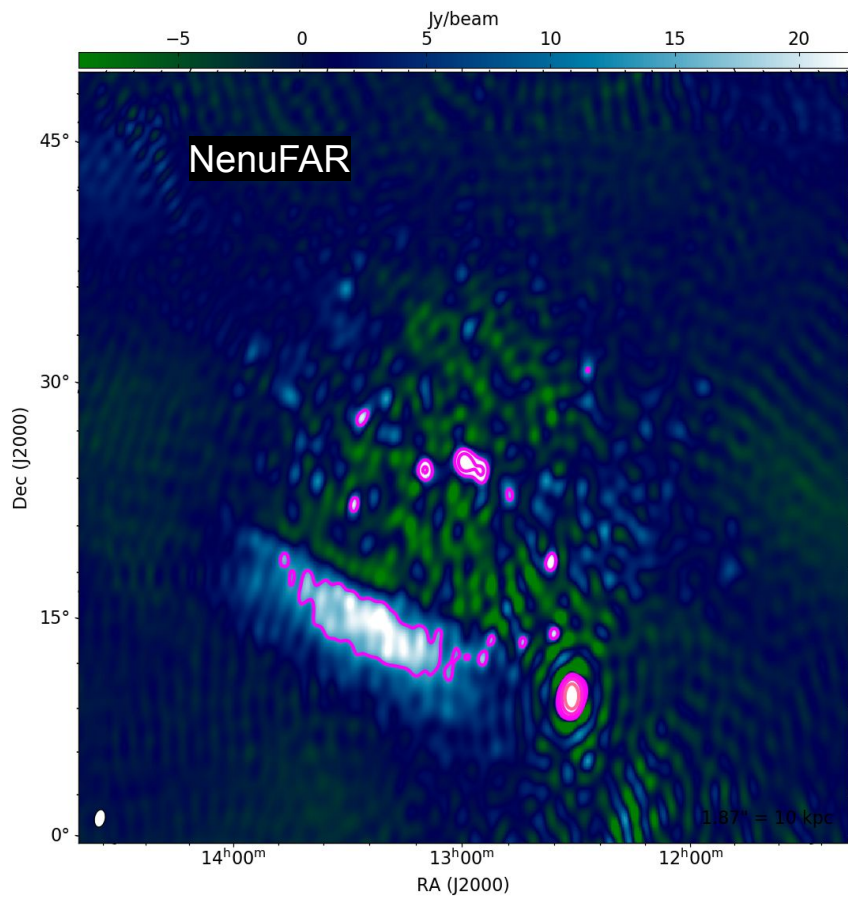
**Abstract:** NenuFAR, the New Extension in Nancy Upgrading LOFAR, is currently in its early science phase. It is in this context that the Cosmic Filaments and Magnetism Pilot Survey is observing sources with the array as it is still under construction - with 57 (56 core, 1 distant) out of a total planned 102 (96 core, 6 distant) mini-arrays online at the time of observation - to get a first look at the low-frequency sky with NenuFAR. One of its targets is the Coma galaxy cluster: a well-known object, host of the prototype radio halo. It also hosts other features of scientific import, including a radio relic, along with a bridge of emission connecting it with the halo. It is thus a well-studied object down to 144 MHz. In this paper, we show the first confirmed NenuFAR detection of the radio halo and radio relic of the Coma cluster at 30 MHz, with associated intrinsic flux density estimates: we find an integrated flux value of  $81 \pm 15$  Jy for the radio halo, and  $38 \pm 8$  Jy for the radio relic. These are upper bound values, as they do not include point-source subtraction. We also give an explanation of the technical difficulties encountered in reducing the data, along with steps taken to resolve them. This will be helpful for other scientific projects which will aim to make use of standalone NenuFAR imaging observations in the future.

**Keywords:** galaxy clusters; observational cosmology; radio interferometry; nenufar

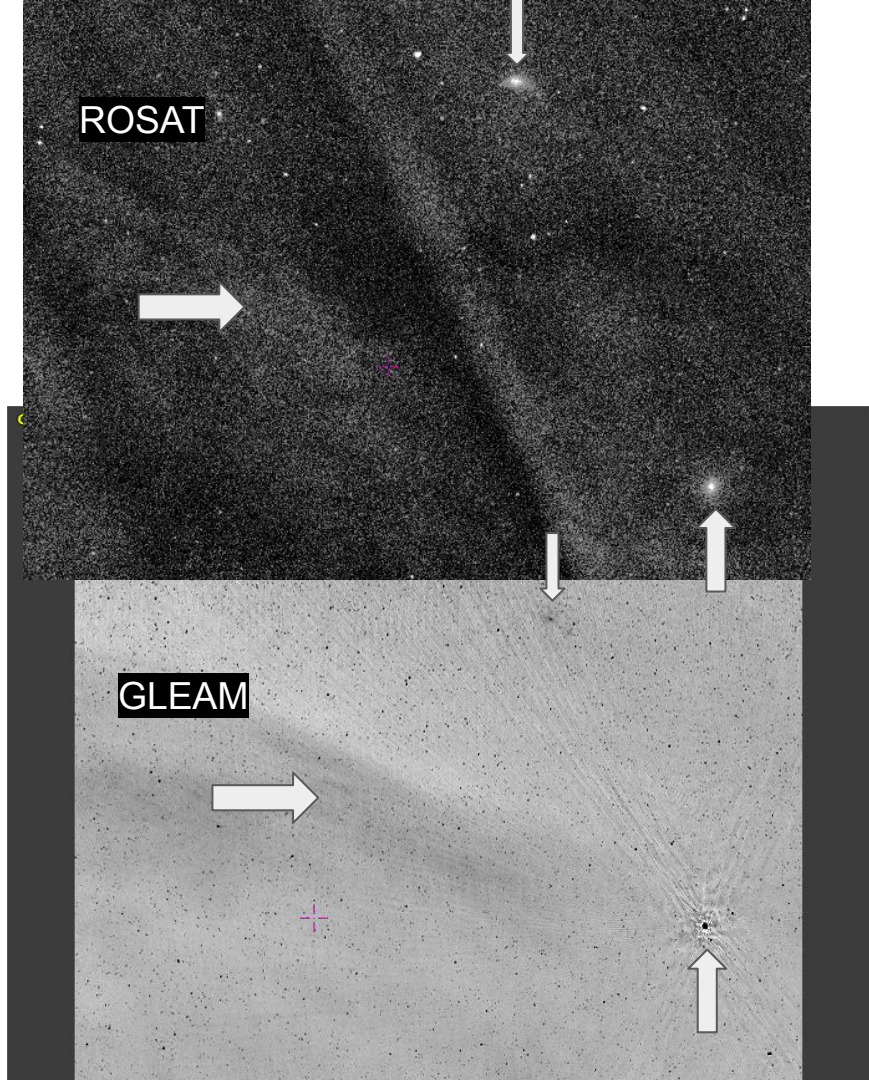
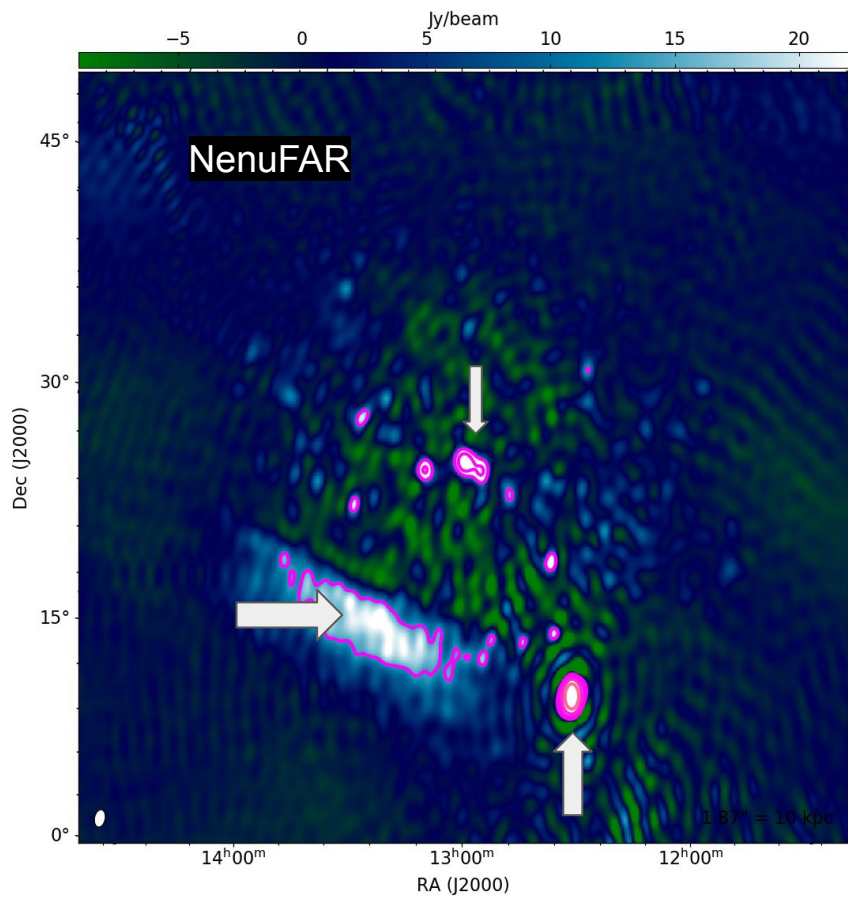
## 1. Introduction

The Coma galaxy cluster is not only one of the first historically observed galaxy clusters [1], but also the first galaxy cluster with the detection of either a radio halo [2] or radio relic [3,4] in the literature. As an object known to host several physical components of considerable scientific interest, it was chosen as the first galaxy cluster to be observed as part of the NenuFAR Cosmic Filaments & Magnetism Pilot Survey project.

# Current Results



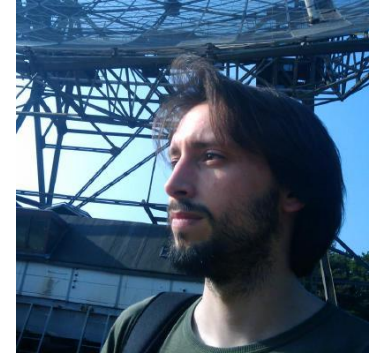
# Current Results



# The Team

KP currently has the following participants:

Etienne Bonnassieux, Annalisa Bonafede, Franco Vazza, Chiara Ferrari,  
Francesco de Gasparin, Cyril Tasse, ...

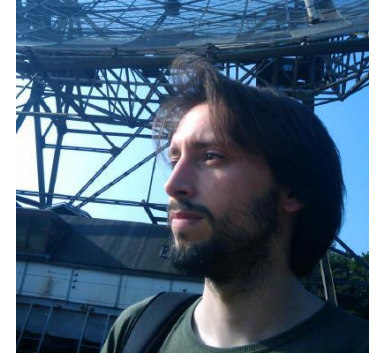




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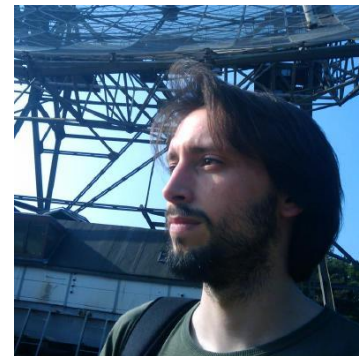


And maybe...you? ;)

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[etienne.bonnassieux@unibo.it](mailto:etienne.bonnassieux@unibo.it)

And maybe...you? ;)