

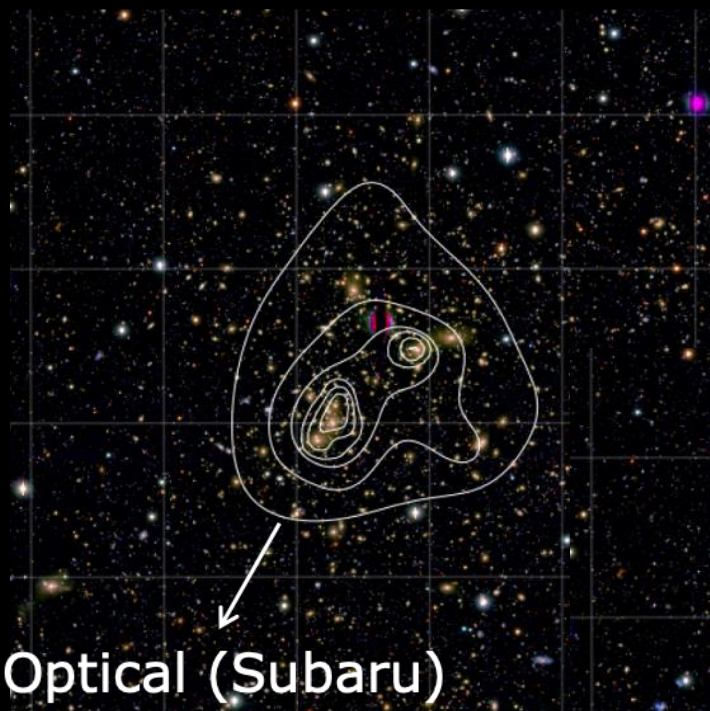
Galaxy Clusters and LSS

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Clusters of galaxies

- ✓ Largest concentration of matter in the Universe,
 $L \sim 2\text{-}3 \text{ Mpc}$, $M \sim 10^{14}\text{-}10^{15} M_{\odot}$
- ✓ Made of : 70-80% of dark-matter, few %
galaxies, 15-20% intra-cluster medium (ICM)

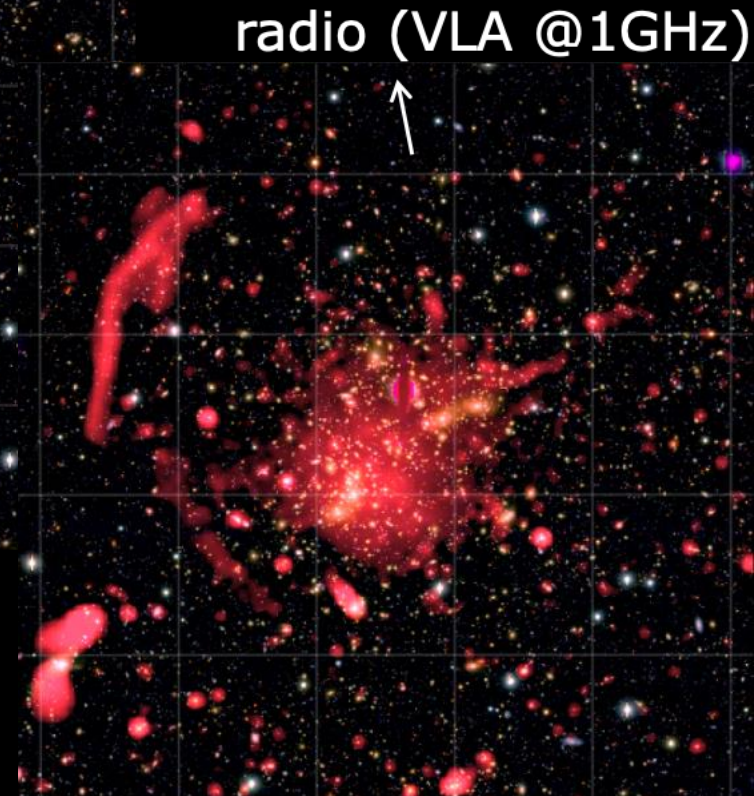
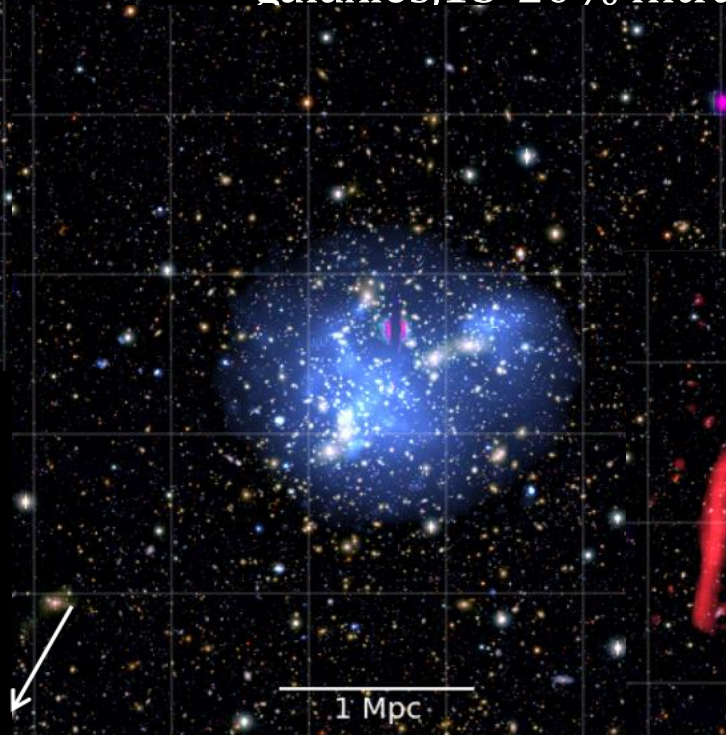


Optical (Subaru)

galaxies (stars)
+
DM (indirect)

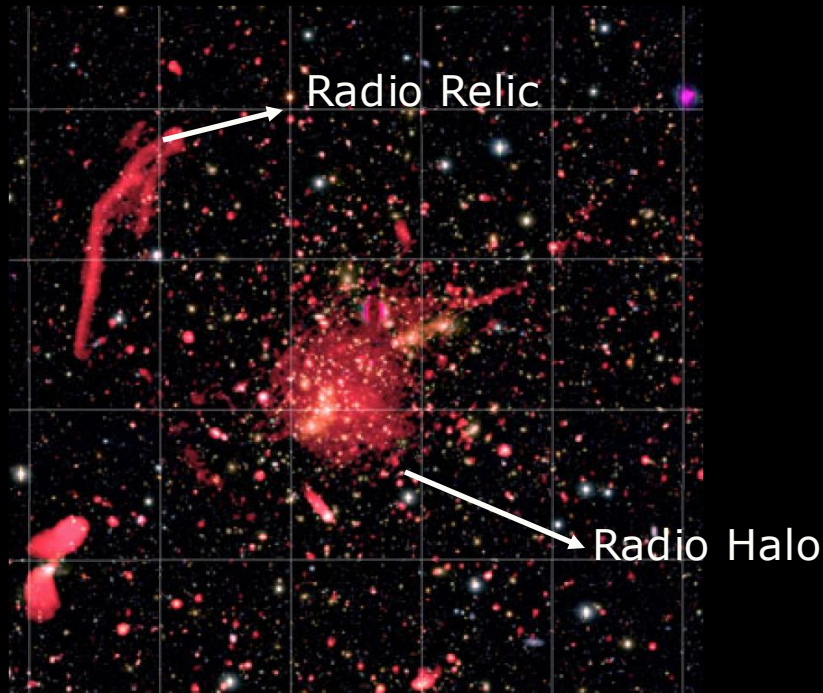
X-rays (Chandra)

Hot ICM:
 $n_e \sim 10^{-1}\text{-}10^{-4} \text{ cm}^{-3}$,
 $T \sim 10^8 \text{ }^{\circ}\text{K}$



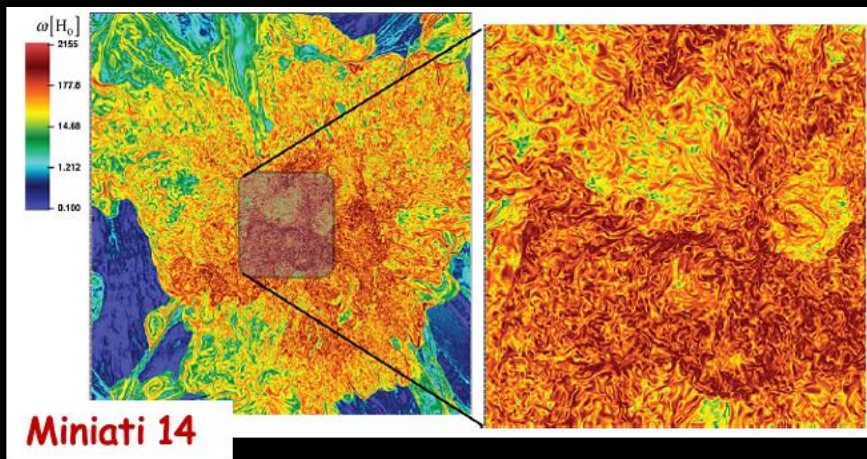
radio (VLA @1GHz)

Cluster-scale diffuse emission



van Weeren + 19

- Diffuse Synchrotron emission in clusters
- Radio Halos & Relics ($\alpha > 1$)
- GeV electrons + μG B-fields in ICM (Mpc scales)
- $\tau_{\text{rad}} \sim 100\text{--}300 \text{ Myr} \ll \text{diffusion} \rightarrow \text{in-situ acceleration}$

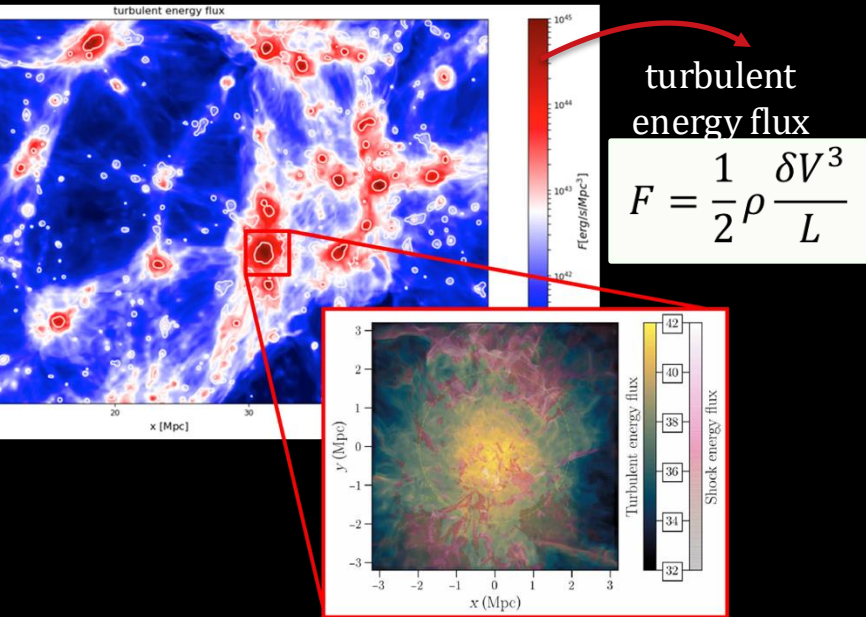


- **mergers** drive **turbulence** and **shocks** in the ICM
- **turbulence** and **shocks** can power mechanisms of particle re-acceleration in the ICM (e.g. *Brunetti & Jones 2014*)

Diffuse emission on larger scale

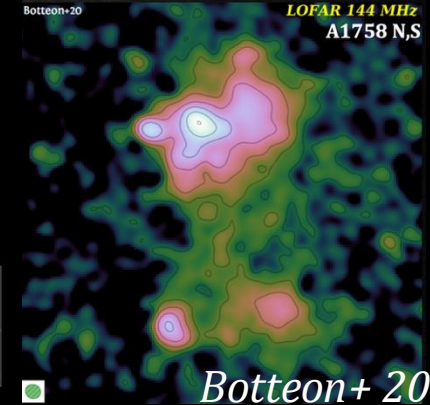
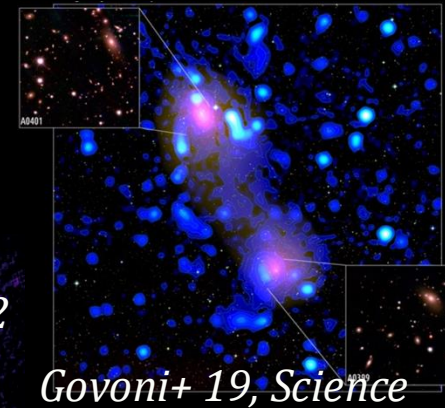
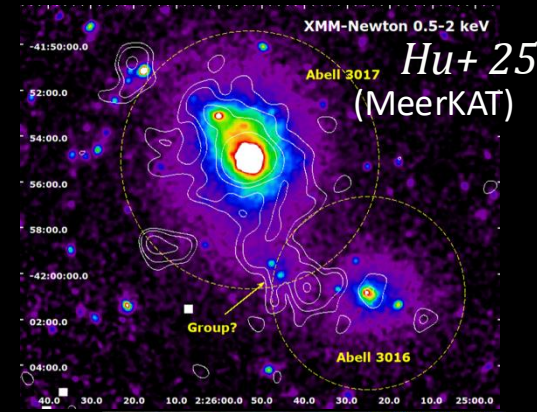


Brunetti & Vazza 2020

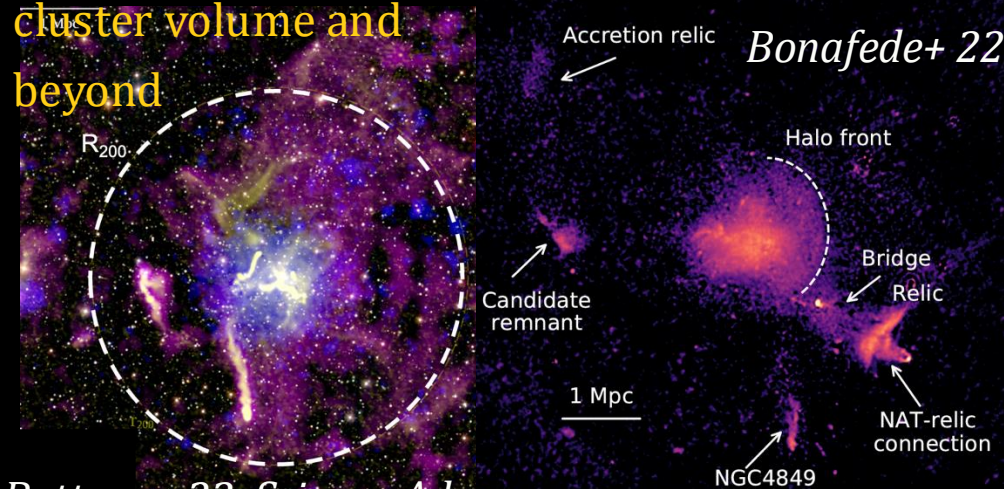


LOFAR
MeerKAT

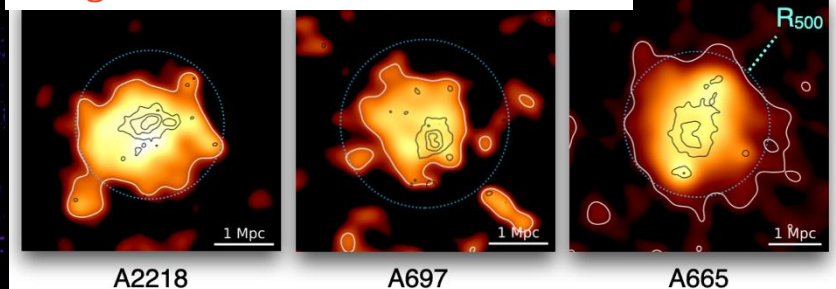
radio bridges
between GCs



Diffuse emission on entire
cluster volume and
beyond



Mega-Halos: Cuciti+ 22, Nature



Galaxy Clusters and LSS (non-thermal components)

Extragalactic continuum SWG:

aims to study the formation and evolution of galaxies and their AGN, as well as **galaxy clusters and the LSS** of the Universe, through deep, high-resolution radio continuum observations.

Magnetism SWG:

use polarization capabilities of SKA to map and understand **magnetic fields across the Universe** — from our Galaxy to the cosmic web.

- **Diffuse emission:** halos, relics, mini-halos in galaxy clusters
- **Cluster outskirts & filaments:** radio bridges, megahalos and ultimately the **cosmic web**
- **Physics:** constrain **turbulence, magnetic fields** and **particle acceleration** in the ICM and LSS

Focus Group: Galaxy Cluster and LSS

co-coordinators: [Virginia Cuciti](#) & Ruta Kale

SWG Members contributing (~55, 1/3 italians):

[Rossella Cassano](#), Chiara Ferrari, Mamta Pommier, Mark Sargent, Dharam Lal, [Francesco de Gasperin](#), Reinout van Weeren, Ruta Kale, [Vazza Franco](#), [Tiziana Venturi](#), Keith Grainge, Martin Hardcastle, [Gianluca Castignani](#), [Andrea Botteon](#), [Alessandro Boselli](#), Matthieu Béthermin (interested), Rémi Adam, [Paolo Marchegiani](#), Marie-Lou Gendron-Marsolais, Eleni Vardoulaki, Riley Keel, Marguerite Pierre, [Alessandro Ignesti](#), Rasha Samir, Pascale Jablonka, Thomas Reiprich, Hongming Tang, Tessa Vernstrom, Takuya Akahori, Pratik Dabhade, Abhirup Datta, Tao Wang, Fatemeh Tabatabaei, [Marisa Brienza](#), Kenda Knowles, Yvette Perrott, [Manuela Magliocchetti](#), Marcus Brüggén, [Gabriella Di Gennaro](#), [Myriam Gitti](#), [Thomas Pasini](#), [Stefano Etori](#), Kohei Kurahara, Ramananda Santra, [Chiara Stuardi](#), Sameer Salunkhe, Ilsang Yoon, [Francesco Ubertosi](#), Arpita Misra, Cathy Horellou, Giulia Macario, Fangxia An, Swarna Chatterjee, Edoardo Altamura

ITALIAN CONTRIBUTIONS TO Advancing Astrophysics with the SKA II

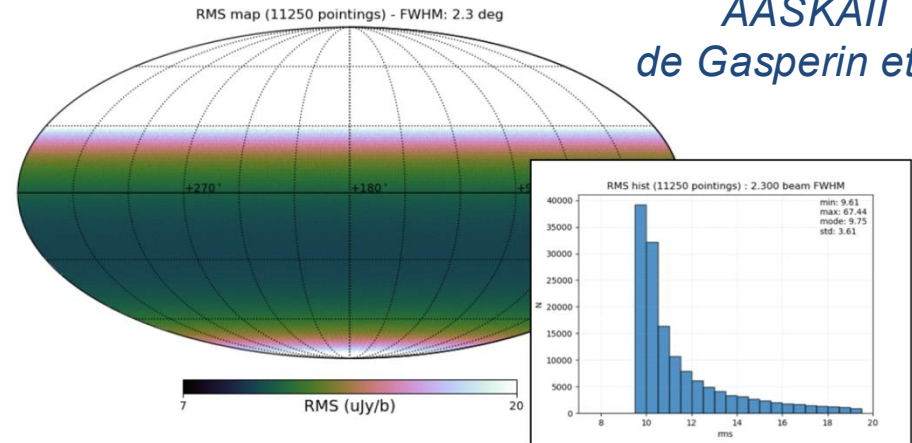
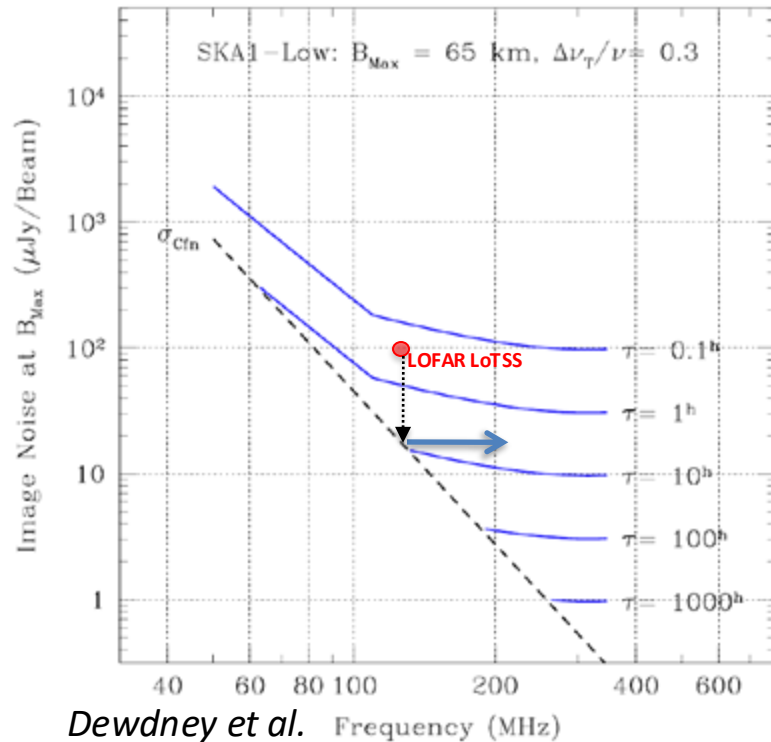
- The SKA view of cool-core clusters: evolution of radio mini-halos and AGN feedback (*M. Gitti et al.*)
- The Cosmic Ray Life Cycle in Galaxy Clusters (*F. de Gasperin et al.*)
- Exploring the physics of ram pressure stripping in clusters and groups with radio continuum observations (*A. Ignesti et al.*)
- Galactic hubs: new insights and SKA view of AGN feedback in galaxy groups (*T. Pasini et al.*)
- The Large-Scale Structure of the Universe through the SKA lenses (*V. Cuciti et al.*)
- Radio Halos in Galaxy Clusters as unveiled by the SKA telescope (*R. Cassano et al.*)

32 abs in ExC SWG

11 on GC+LSS

6 italian PI

SKA-Low continuum surveys



Simulated SKA-Low Continuum Survey

- 2 simultaneous beams, 125–275 MHz
- Resolution: $\sim 8''$ (robust 0)
- Sensitivity: $\sim 10 \mu\text{Jy/beam}$ (incl. confusion)
- Footprint: $\text{Dec} \leq +30^\circ$, total time 5625 hr
- $\sim 10\times$ deeper than LoTSS (Shimwell+17)

SKA-Low Continuum Survey (AA4, 150 MHz, 200 MHz BW)

RMS $\sim 20 \mu\text{Jy/beam}$ at $\sim 10''$ $\rightarrow$ limited by confusion

Moving to $> 200 \text{ MHz}$ reduces confusion

Expected noise $\sim 10 \mu\text{Jy/beam}$ (confusion $\sim 3 \mu\text{Jy/beam}$)

Top priority

Magnetism SWG

ITALIAN CONTRIBUTIONS TO SKA WHITE BOOK AND TOOLS

Contributions with **Italian PI-ship**:

- 1. Study of magnetism in clusters with RM from discrete sources (*Loi, Vacca, Stuardi, Govoni, Murgia, Bonafede, Carretti, Maccagni, et al.*)
- Polarization properties of diffuse sources (in clusters and filaments) to constrain magnetic fields (*Vacca, Govoni, Murgia, Loi, Feretti, Marchegiani, Giovannini, Carretti, Gitti, Cabriolu*)
- Expectations with new statistical Bayesian tools for disentangling extragalactic RM (*Vacca, Cabriolu, Carretti, Feretti, Govoni, Loi, Murgia, Paladino*)

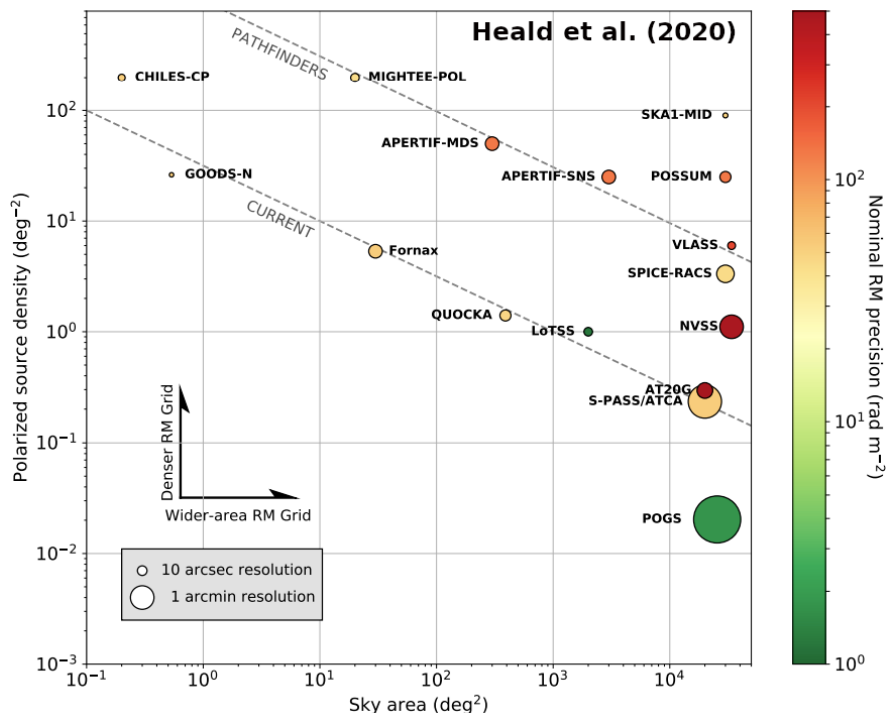
Contributions with **Italian co-I.**:

- 1. Milky Way & nearby galaxies** (*4 chapters with Bracco, Padovani, Armillotta*)
- 2. Dark matter** (*1 chapter with Bernardi, Marchegiani*)
- 3. Origin of cosmic magnetism** (*1 chapter with Vazza, Carretti, Vacca, Loi*)

Software developed by the Italian community:

1. Data reduction pipeline in polarization (*CARACal Loi et al. 2025*)
2. Software to constrain magnetic field properties (*FARADAY Murgia et al. 2004, MIRÒ Bonafede et al. 2013*)
3. Software for RM decomposition (*DEFROST, Vacca et al. in prep.*)

Magnetism SWG



Top priority of Magnetism SWG:
polarization survey with SKA-Mid over
 30,000 deg² (10–15 min/pointing)

Band2: 950-1760 MHz
 Resolution: 10'' (AA*) – 1'' (AA4)
 Sensitivity: 3 (AA*) – 2 (AA4)
 μJy/beam

RM-grid

~80–110 pol source/deg²
 up to 3 millions of RM



targeted observations (≥10-50 h on
 individual targets)