A scientific roadmap for VLBI in the next decade

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Abstract

The European VLBI Network (EVN) has started a process to define the new scientific roadmap for VLBI in the next decade. The new astrophysical frontiers which are opening with the current and new generation of radio interferometers, as well as several space- and ground-based facilities in other bands, highlight the transformational role and unique potentials of arrays with mas and sub-mas angular resolution at cm and mm wavelengths in a number of key science areas. This effort is ongoing within the Joint Institute for VLBI – ERIC (JIVE) and involves a large team of astronomers worldwide.

EC-H2020 JUMPING JIVE

The VLBI vision document currently under preparation is the main deliverable of the workpackage ***The future of VLBI (WP7)*** in the project JUMPING JIVE, supported by the EC under the framework programme H2020.

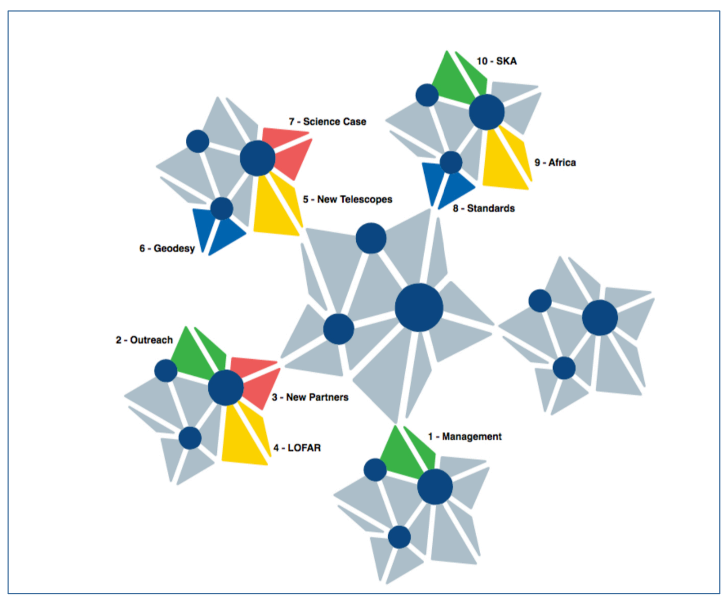

Figure 1. Structure of the JUMPING JIVE Project.

WPs 6,7,9 and 10 are related to the VLBI "capacity of doing science". Beyond the delivery of the VLBI Science Case, the development of VLBI in Africa and the integration of VLBI capabilities within phase-1 SKA radio telescopes are milestones of the project.

The VLBI Science Vision Document

The document is addressed to the astronomical community at large and covers a range of science areas going from cosmology to planetary systems. A comparison with the previous VLBI Science case (the EVN2015 document) clearly shows that the scientific impact of VLBI has grown enormously over the past 15 years. The improved sensitivity of global VLBI arrays makes the ***sub-mJy Universe*** routinely accessible at milliarcsecond resolution, and the relevance of multi-band and multi-messenger coordinated campaigns of the ***transient Universe***, are considerably broadening the astrophysical framework where VLBI is playing key roles. The prospects for further sensitivity improvements with increased recording rates and the potential inclusion of new antennas and new receivers in the EVN are the premises for novel science cases. Here we present a very limited selection of them.

A window on cosmology

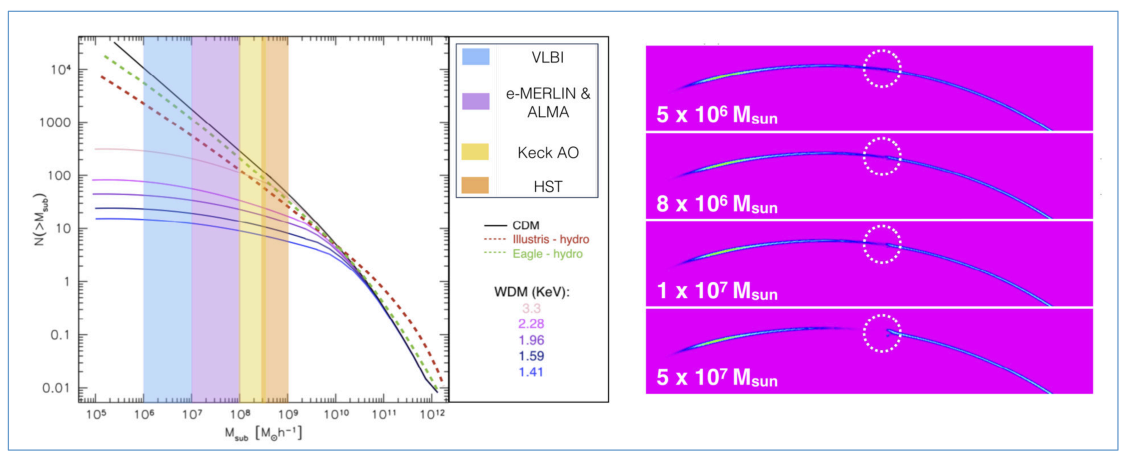

Figure 2. Right: Despali & Vegetti 2017. Left: McKean et al. 2015

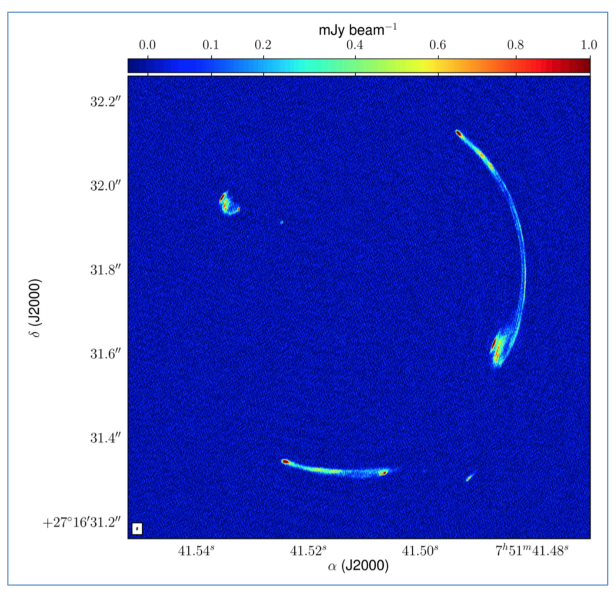

Figure 3. Spingola et al. 2018

Depending on their mass, dark matter halos produce different signatures in the radio images of gravitational arcs. The image sensitivity and fidelity of VLBI allows to address the 10^6-10^7 M_{Sun} range.

The transient Universe and multimessenger astronomy

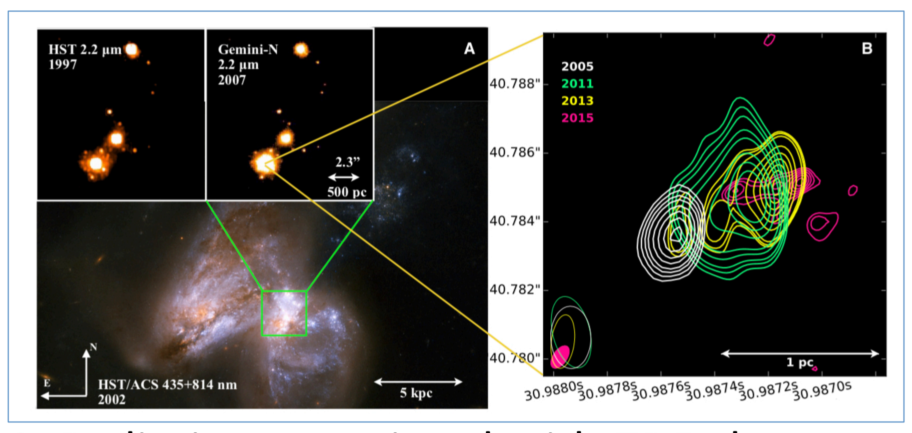

Figure 4. Radio jets associated with TDEs have remained elusive until the detection and monitoring of Arp-299A AT1. The VLBI images are aligned with an accuracy better than 50 μas (Mattila et al. 2018)

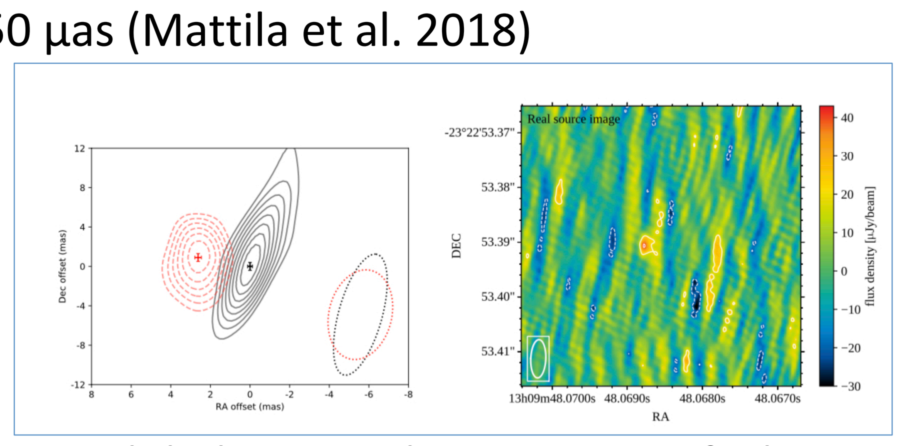

Figure 5. Global VLBI observations of the GW170817 afterglow provided unique evidence for collimated jet ejecta associated with the NS-NS merger (Left: Moley et al. 2018; Right: Ghirlanda et al. 2019).

High Mass Star Forming Regions

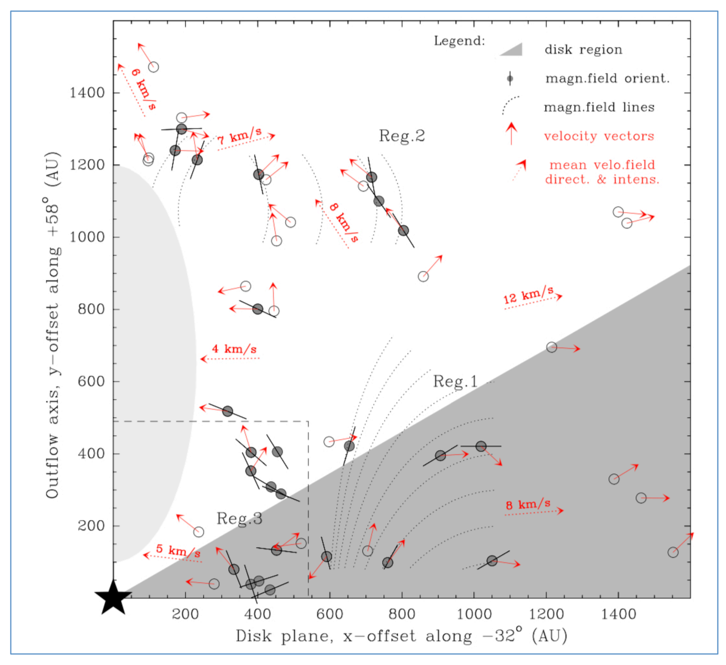

Figure 6. Sanna et al. 2015.

The detection and study of polarized emission from different maser species is particularly challenging. At the same time the knowledge of the distribution of the magnetic field in star-forming regions and of the proper motion of the masers themselves are key ingredients for the theoretical models od star formation.

The scientific content of the VLBI Science Vision provides an insightful overview of the developments and future directions envisaged for the European VLBI Network. Improved sensitivity and u-v coverage are the main obvious requirements from the users' community, together with a broader frequency coverage. Recording bitrates up to 64 Gbps are within reach, and full operations between EVN and eMERLIN already ensure a seamless u-v coverage from sub-arcsec to sub-mas scales. Wideband receivers for the EVN, including the BRAND receiver (1.5-15.5 GHz), are under development and operations up to 100 GHz will soon be feasible at least with a subset of EVN antennas.

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