LOTAAS

LOFAR Tied-Array All-sky Survey

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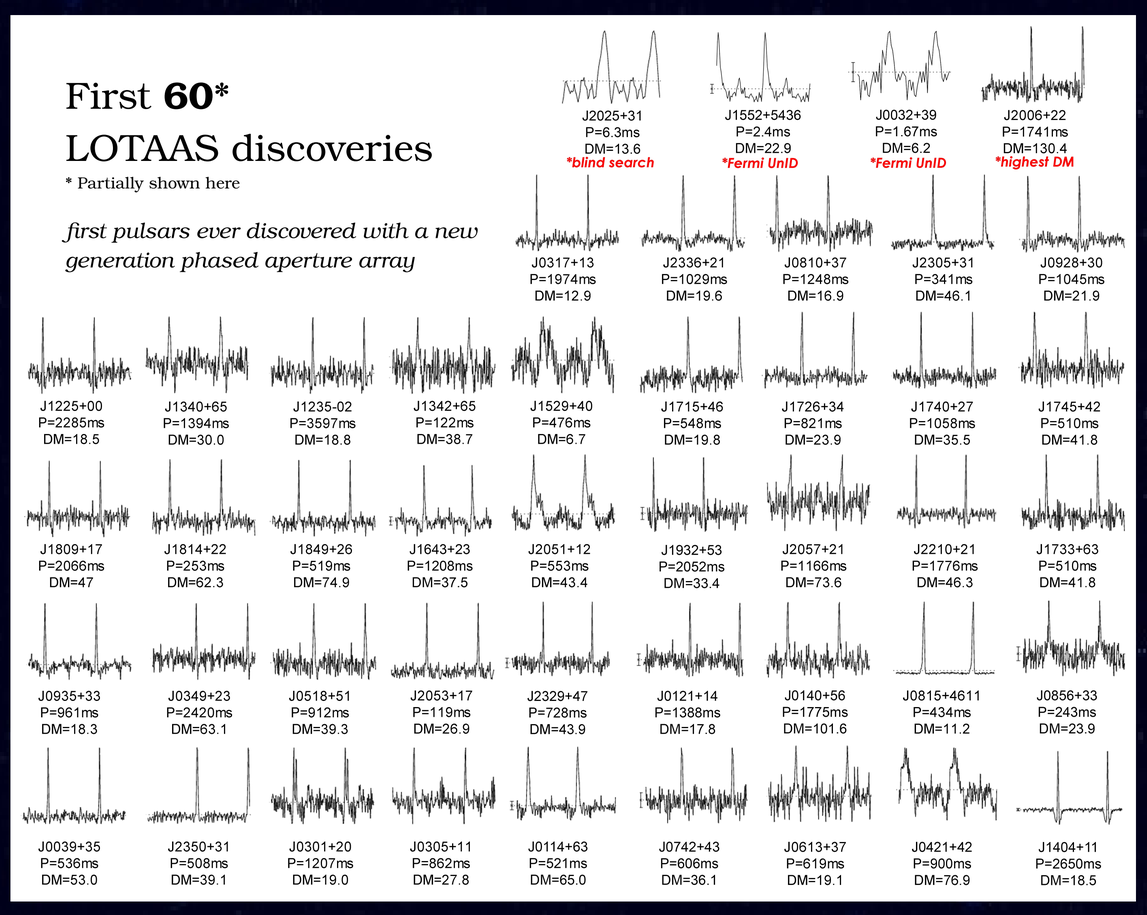
LOTAAS is an all-sky survey for pulsars and fast transients

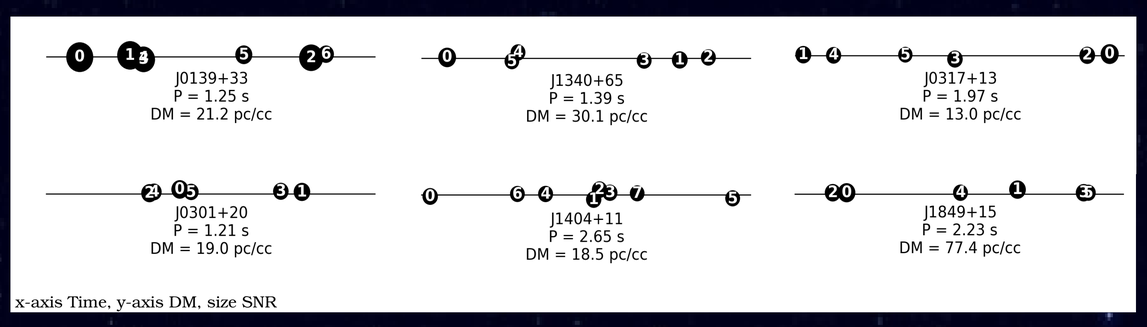
LOTAAS is the LOFAR Tied-Array All-Sky Survey, an ongoing LOFAR all-Northern-sky survey (Coenen et al. 2014, A&A, 570, 60). It uses the 12 HBA sub-stations on the LOFAR Superterp. Each LOTAAS survey pointing is comprised of three incoherent array beams, and together these cover ~30 square degrees of sky. Within the FoV of each incoherent beam we also form a Nyquist-sampled, hexagonal grid of 61 tied-array beams. Together, this set of 3×61 tied-array beams cover a survey area of ~10 square degrees at a sensitivity roughly twice that of the ongoing GBNCC survey. Lastly, for each incoherent beam an additional 12 tied-array pointings are generated and pointed towards any other cataloged pulsars that fall within the incoherent FoV. These additional beams provide valuable data on known sources simultaneous with the survey observations (e.g. Pilia et al. 2016, A&A, 586, 92). All together, there are 3×61+3×12+3 = 222 beams per survey pointing. In other words, this is a survey approach unlike any other and a unique stepping stone on the path to surveying with SKA-Low. With a bandwidth of 32 MHz, a spectral resolution of 12 kHz, and a sampling time of 492 μs, LOTAAS generates data at an astounding rate of 35 Gbps. Each 1-hour pointing produces 16 TB of raw data.

Huge number of false candidates: machine-learning classifiers

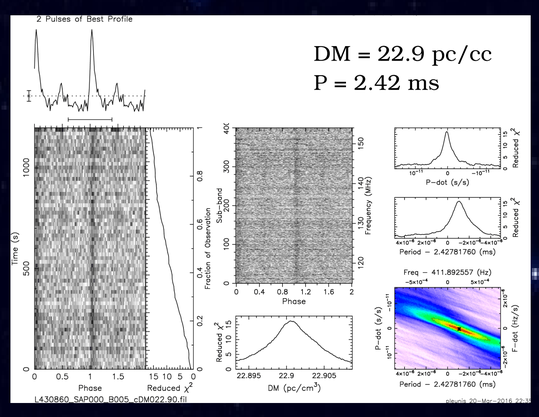
- From 100,000,000 to 20 single-pulse candidates per observation (Michilli et al., in prep.)
- From 20,000 to 200 periodic candidates per observation (Tan et al., in prep.)

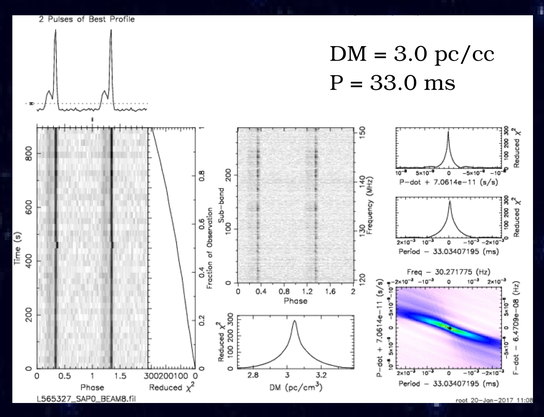


Periodicity search



Single-pulse search





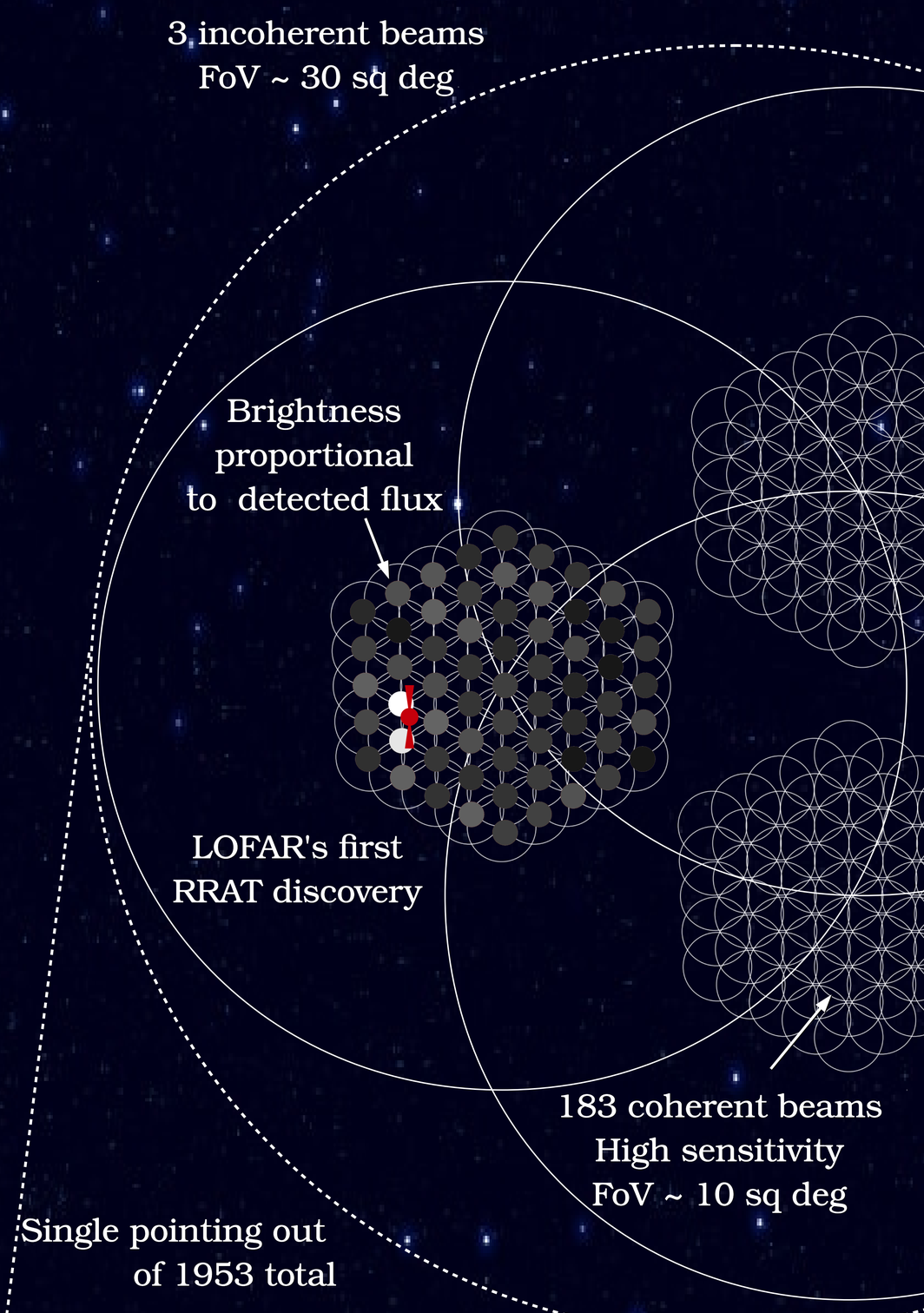
Interesting examples

First LOFAR millisecond pulsar

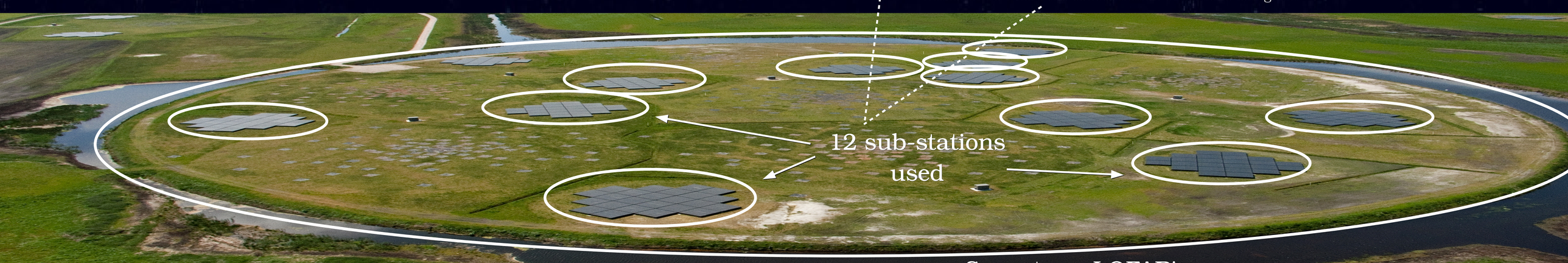
Found in a parallel project targetting Fermi unassociated sources. The data is coherently de-dispersed at different trials before an acceleration search is performed.

First LOFAR binary pulsar

Preliminary results suggest a wide orbit with a massive white dwarf companion. At a DM of only 3 pc/cc, it is one of the closest binary pulsars known.



LOFAR is a low-frequency phased-array radio telescope composed of thousands of antennas which are divided into stations that are distributed in different European countries (van Haarlem et al. 2013, A&A, 556, 2). For fast transient observations, it is possible to observe in a mode called *beam-forming*, where signals from different stations are added together permitting to reach sub-millisecond time resolution at the cost of spatial information (Stappers et al. 2011, A&A, 530, 80). Two types of antennas are available in LOFAR, due to the higher sensitivity and less RFI present, only High-Band Antenna antennas are used to observe with LOTAAS in the range 119-151 MHz. The signals from different stations can be added incoherently, which retains the larger field-of-view of single stations, or coherently, which permits to have a higher sensitivity but a lower field-of-view. In order to have a good compromise, LOTAAS uses only antennas located in the *Superterp*, a circular area in the Netherlands where the concentration of stations is highest.



Superterp: LOFAR's core

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erc European Research Council

NWO Netherlands Organisation for Scientific Research

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