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Strategies to optimize transient hunts using low-frequency radio surveys on timescales of seconds to years

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Extended Abstract

Over the last two decades, radio transients have been discovered all across the transient phase space, which spans orders of magnitude in transient timescales, observing frequency and flux density. Phenomena that are transient in the radio sky include pulsars, FRBs, flare stars, cataclysmic variables, X-ray binaries, GRBs and AGN. In this talk I will discuss two projects that target low-frequency radio transients (150 MHz) at long and short timescales, years to seconds respectively. The first study [1] describes a search for long-timescale low-frequency radio transients using the TGSS ADR1 [2] and LoTSS DR2 [3] catalogues. The main challenge in finding transients in the image domain is to suppress the number of false positives. This is generally the case in transient studies, but even more so when one uses survey catalogues directly. While this study does not identify any transient sources, it presents new techniques to suppress the number of false positives. Suggested strategies are to filter out compact sources, correct for misaligned flux scales between surveys and filter out sidelobe artefacts around bright sources. These strategies are applicable to future radio transient searches.

Traditionally, transient studies in the image domain are notoriously computationally intensive, because one has to create images for each timestep. In our second project we explore the use of subtraction images as a new method to find radio transients on timescales of seconds to hours, using LOFAR Two-metre Sky Survey (LoTSS) data. Subtraction images are created by subtracting the full sky model from the UV-plane and imaging shorter timescale snapshots, which is done within the state-of-the-art DDFacet framework [4] for direction dependent radio imaging. Imaging of these short-timescale snapshots creates an image that shows the difference between the visibilities measured during the snapshot time and the full observation sky model, removing sources with constant flux density, while highlighting transient or highly variable sources.

The main benefit of this novel technique, compared to traditional methods, is a greatly reduced computational cost for imaging, which is critical when imaging full 8-hour observations on an 8 second cadence. Secondly, the subtraction images should, in theory, only contain the sources that are not in the sky model, or sources with a variable flux density compared to the sky model, which simplifies a transient search. Lastly, by subtracting the full 8-hour sky model from the shorter timescale snapshots, one can remove the high confusion noise from the snapshots, which allows for a deeper transient search. We will show simulated transient sources to show the merit of subtraction images and initial results of our transient search in LoTSS data.

References

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