

## The Importance of Radio Arrays Dedicated to Time-Domain Science

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Radio transients are both the sites and signatures of the most extreme phenomena in our Universe: e.g. exploding stars, compact object mergers, black holes and ultra-relativistic flows. They also have the potential to act as probes of the intervening medium on all scales, up to and including cosmological distances. As such they are invaluable probes for subjects as diverse as stellar evolution, relativistic astrophysics and cosmology.

Radio monitoring observations of transients provide key scientific aspects such as measuring kinetic feedback, which often originates in relativistically moving ejecta, trace the evolution of key physical processes such as cooling, and detect changes in the circumstellar structure in the vicinity of the transient. This can be applied to a plethora of transient phenomena including gamma-ray bursts (GRBs), supernovae (SNe), tidal disruption events (TDEs), and last but not least, gravitational wave (GW) sources.

A radio monitoring program on AMI-LA has been operating over the last several years (led by Fender and recently also by Horesh). Typically, 20-30% of all observing time on the telescope is used for our program. In many cases, we have managed to outperform larger radio facilities (e.g. JVLA) because we have the time available to monitor sources (as long as they are above our ~0.1 mJy daily detection limit) or are able to implement novel strategies, namely the robotic rapid response mode, ALARRM.

Turning first to the ALARRM mode, this was implemented to facilitate rapid follow-up of GRBs to provide an unbiased sample of early time radio emission from these events. The program was announced in Staley et al. (2013) and culminated in the most comprehensive and unbiased catalogue of early-time GRB radio emission ever published (Anderson et al. 2018). Highlights of this program include early-time radio peaks from at least two GRBs, indicative of (rare) reverse-shock emission (e.g., Anderson et al. 2014). Another notable example is the very rapid (minutes) response to a bright gamma-ray flare from a nearby low mass binary system, DG CVn, resulting in the discovery of prompt radio flaring associated with the source (Fender et al. 2015).

Most of our observations with AMI-LA are obtained via our ad hoc program, in which we are usually able to insert sources into the observing queue on a timescale of one day or less, and are able to override other observations and/or choose our own priorities. This allows us, for example, to implement intensive monitoring (e.g. 6 hours per day, every day) of active sources, for limited periods of time, or to monitor slowly evolving extragalactic sources for long periods (years). Examples of the longer-term monitoring program are the extraordinary multiple-peaked radio light curve of the metamorphosing supernova SN2014C (Anderson et al. 2017), the long-term light curve of the nearby 'thermal' Tidal Disruption Event ASASSN-14li (van Velzen et al. 2016, Bright et al. 2018), and the peculiar radio light curve of SN2018COW (Horesh et al., in prep).

AMI-LA is only one instrument and thus the capacity to study a large number of transients is limited. Taking into account the revolution in the field of time-domain astronomy over the last decade and the unique scientific achievements of AMI-LA, the need for more small dedicated time domain radio arrays is clearer than ever. Otherwise, the opportunity to capitalize from the many transient discoveries expected over the coming decade might be lost. Moreover, AMI-LA has its own limitations such as observing in a single frequency of 15.5 GHz and poor spatial resolution due to its large 30" beam. Hopefully, if new dedicated radio arrays are built, they will be designed to overcome these limitations. We note that there may be opportunities to transform old small arrays to time-domain arrays. One examples it KAT7 (the test bed telescope of MeerKAT), that with a relatively small investment can become a time domain array.

## References

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