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Afterglow observations of radio transients: origin and host properties

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Radio transients originating from a cataclysmic event can include (amongst others) the tidal disruption of a star by a supermassive black hole, or the core collapse or merger of massive stars resulting in a supernova (SN) or a gamma-ray burst (GRB). The relativistically expanding ejecta from this can produce and sustain an afterglow due to synchrotron processes involving direct emission, self-Compton, and from the interaction between the ejecta and the surrounding circum-nuclear medium (CSM). In a tidal disruption event (TDE), a relativistic jet can be produced either during the early super-Eddington accretion phase or at later epochs when the accretion rate decreases below a critical value; in a GRB, the ejecta can be a spherically expanding structure (off-axis). Radio very long baseline interferometry (VLBI) imaging observations at staggered epochs (over timescales of days to months) can provide information on the afterglow structure, proper motion, flux density and spectral index evolution. This information can help constrain the nature of the transient by distinguishing between proposed models, provide estimates of the number density and radial distribution of the CSM (inputs to dynamical models), probe shocks and acceleration of particles at the interfaces, and help constrain the putative jet properties including the Lorentz factor and opening angle. We present preliminary results based on a 1.67 GHz European VLBI network pilot experiment which imaged the transient source AT2018cow (in the galaxy CGCG 137-068 at $z = 0.014$) whose origin remains debatable with proposed models including SN Ic, GRB or TDE. Though the source is not resolved, the estimated flux density can help in placing the evolutionary stage of the source (size, spectral index and energetics) when employed in conjunction with existing radio observations.