Transient Science with the VLASS

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Abstract

We discuss the potential science return through detection of transients in the VLA Sky Survey (VLASS). The VLASS will probe known classes of Galactic (active stars, brown dwarfs, X-ray binaries, novae, magnetars) and extragalactic (SNe, GRBs, TDEs, AGN) radio transients and likely reveal new populations. We consider the return from a large two-epoch 30,000 $\deg^2$ survey and a multi-epoch, multi-frequency, medium-area 1,000 $\deg^2$ of the Galactic Gap and Galactic Plane. In all cases, a successful transient program will require near real-time data reduction, source extraction and transient identification pipelines to allow timely follow up at radio, optical and higher energy bands. Accompanying VLA and VLBA programs should be coordinated with the VLASS to allow rapid follow-up of detected transients.

1 The Dynamic Radio Sky

This white paper discusses the VLASS in the context of transients on timescales > 1 s. Please refer to the white paper by Law et al. for transients on timescales < 1 s.

The 2010 Astronomy and Astrophysics Decadal Survey highlights time domain astronomy as an arena with great potential for new discoveries. Space-based observatories, such as the Swift Gamma-Ray Burst Mission and the Fermi Gamma-ray Space Telescope, have pioneered real-time monitoring of large fractions of the X-ray and gamma-ray skies, while ground-based, large synoptic surveys such as the Palomar Transient Factory (PTF), the Catalina Real-time Transient Survey, the Panoramic Survey Telescope and Rapid Response System (Pan-STARRS), as well as the planned Large Synoptic Survey Telescope (LSST), take advantage of progress in optical detector technology to open up new fields in the study of optical transients on timescales of seconds to years.

By contrast, the study of radio transients is a fledgling field; the narrow field of view offered by previous generations of multi-dish radio interferometers has been ill-suited to the repeated imaging of large swathes of the sky with the sensitivity needed for the systematic exploration of the dynamic radio sky on timescales > 1 s (see Cordes et al. 2007 for a review). However, although comparatively poorly sampled, evidence suggests that radio wavelengths are equally ripe for discovery. Many new classes of radio transients have been discovered in follow-up observations of targets discovered in surveys at optical and higher energies. These include radio afterglows from gamma-ray bursts (GRBs) (Frail et al. 1997), a giant flare from a Soft Gamma-ray Repeater (SGRs) (Cameron et al. 2005, Gaensler et al. 2005), the detection of periodic pulses from brown dwarfs (Hallinan et al. 2007) and a tidal disruption event around an otherwise dormant super-massive black hole (Zauderer et al. 2011).

However, only, synoptic surveys offer the potential to systematically characterize radio transient phase space. Transient events at radio wavelengths are often distinct in terms of emission process, energetics, characteristic timescale and detectability from their counterparts in optical and higher energy wavebands, and in some cases are unique to the radio regime. There has been some success from blind searches for transients in archival VLA data (Bower et al. 2007; Thyagarajan et al. 2011, Jaeger et al. 2012), but such efforts are hampered by the lack of contemporaneous follow-up observations, precluding full characterization and association with higher energy counterparts. Rapid data reduction, transient identification and follow-up are essential to maximizing the success of future radio transient surveys, including transient searches in VLASS data.

Happily, radio astronomy is undergoing a revolutionary expansion in capability that bodes well for transient science. At cm wavelengths, new facilities such as APERTIF, MeerKAT and ASKAP will employ large numbers of small dishes and/or phased array feeds to effectively increase entendue, and thus survey speed, with the exploration of the time domain identified as a primary science driver (Murphy et al. 2012). Meanwhile, the Jansky VLA takes advantage of upgrades to receivers, DSP and data transport that have enabled a 10-fold increase in continuum sensitivity and an associated vast increase in survey speed. Critically, the upgraded Jansky VLA is the first such interferometer to reach full science operations with sufficient survey speed to routinely detect known

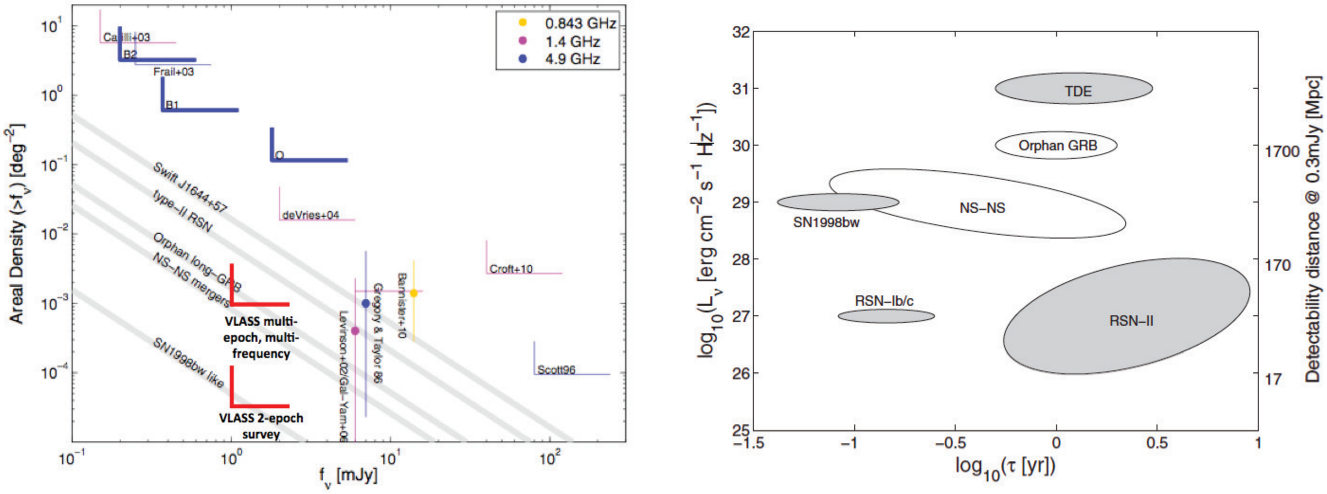

Figure 1. ***Left:*** *Predicted cumulative areal density of transients as a function of peak flux density, as well as limits reached by previous surveys. The sensitivity of a 30,000 deg^2 2-epoch survey and a single epoch of a multi-epoch, multi-frequency, medium-area 1,000 deg^2 are also shown.* ***Right:*** *Predicted specific luminosity vs. time scale for several types of radio transients. White zones correspond to optically thin sources, while gray zones represent sources that are expected to be optically thick before maximum light and optically thin afterwards. (adapted from Frail et al. 2012)*

populations of scientifically interesting radio transients using relatively short allocations of observing time (Fig. 1). The VLASS will potentially probe known classes of Galactic (active stars, brown dwarfs, X-ray binaries, novae, magnetars) and extragalactic (SNe, GRBs, TDEs, AGN) radio transients and likely reveal new populations. Transient science with the VLASS will particularly benefit from the inclusion of the VLITE/LOBO system commensally observing at frequencies < 500 MHz, potentially probing distinct populations simultaneously to unprecedented depth.

2 Extragalactic Radio Transients

The dominant population of slowly varying extragalactic radio transients is expected to be the afterglows associated with catastrophic explosive events, such as supernovae (SNe), gamma-ray bursts (GRBs) and tidal disruption events (TDEs). In all cases, synchrotron emission is produced through the interaction of explosive ejecta with the surrounding interstellar medium and can provide the most reliable calorimetry of the associated explosion.

It is particularly notable that the detectable rate of extragalactic explosive transients may be much higher at radio frequencies than X-rays or gamma-rays, as the latter is often subject to narrow beaming that is absent for the radio emission. Detecting such "orphan afterglows" associated with GRBs, for example, will thus yield an observational measure of the poorly constrained inverse beaming factor for GRBs (estimated to be $10^2 - 10^3$; Piran et al. 2013), as well as total energy output. Similarly, unlike optical surveys, radio observations are not limited by extinction with important ramifications for the study of supernovae. Blind radio surveys provide unique access to the population of heavily obscured SNe (Gal Yam et al. 2006), undetectable in optical surveys, which in turn can provide constraints on the star formation rate in the local Universe.

More recently the detection of a transient associated with the otherwise dormant supermassive black hole at the center of a normal galaxy at $z = 0.354$ has revealed a new class of extragalactic radio transient. Initially detected as a hard X-ray transient, Swift J1644+57 (Burrows et al. 2011), subsequent follow-up observations revealed a bright, compact self-absorbed radio counterpart (Zauderer et al. 2011). This event has been attributed to tidal disruption of a star as it passed close to the supermassive nuclear black hole of the associated galaxy (Bloom et al 2011), providing a new means to probe the mass and spin of quiescent nuclear black holes. Whereas the X-ray emission from Swift J1644+57 was strongly beamed, the radio emitting region is mildly relativistic and therefore not narrowly beamed, indicating that blind radio searches may the most fruitful means to unearthing such tidal disruption events (TDEs). Indeed, preliminary estimates suggest that TDEs may be the most numerous extragalactic radio transient (Frail et al. 2012). However, once again, as is the case with GRBs, the inverse beaming fraction is poorly constrained and the true extent of the radio population can only be revealed by synoptic radio surveys.

2.1 Electromagnetic Counterparts to Gravitational Wave Events

Perhaps the most significant class of extragalactic radio transient to be revealed by the VLASS will be the merger of binary neutron star systems. Advanced LIGO (aLIGO) and Advanced Virgo (AdV) are scheduled to commence collecting data in 2015 and are expected to eventually yield the first direct observations of gravitational waves. The network will not be at full design sensitivity in 2015, but will grow in capacity over subsequent science runs (2016-2019) as detectors improve and with the eventual installation of a LIGO detector in India 2020 (LIGO Scientific Collaboration 2013).

One of the most difficult challenges in the wake of a gravitational wave detection, will be detection of a corresponding electromagnetic counterpart, the "smoking gun" that will confirm the gravitational wave detection, localize the source and deliver diagnostic information to maximize the science delivered. With two detectors, sources will be localized to regions of hundreds to thousands of square degrees; three detectors can potentially restrict the source to sky regions several tens of square degrees in area.

Compact binary coalescences, particularly the inspiral of binary neutron star (BNS) systems, are expected to be the most common source for detection and also the most promising to yield a corresponding electromagnetic counterpart. However, the rate of BNS mergers is very poorly constrained (10^{-8}–$10^{-5}\,\mathrm{Mpc}^{-3}\,\mathrm{yr}^{-1}$), and, consequently, so is the predicted gravitational wave detection rate for eLIGO and AdV. Information gleaned from conventional astronomy thus far has been limited. BNS mergers are thought to be the likely progenitor of short gamma ray bursts (S-GRBs), but only a small fraction of such events are detected in gamma rays due to the narrow beaming of the emission. The fraction of S-GRBs that are not detected due to this narrow beaming is also poorly constrained. It is likely to be large however ($10^2 - 10^3$), as no S-GRB within range of aLIGO and AdV has been detected during the 9 year Swift mission. It is clear that an unbeamed electromagnetic signature is required, both to 1) determine the true rate of BNS merger events to allow well defined predictions for the aLIGO and AdV era and 2) to provide a reliable means to unambiguously identify and localize a counterpart to a GW event.

The radio emission produced by the mildly relativistic outflows interacting with the surrounding medium in the wake of a BNS merger has recently been highlighted as one of the most promising means to detect such events (Nakar & Piran 2011). This radio afterglow would be produced in the weeks/month following the merger, with frequencies of $\sim 1.4\,\mathrm{GHz}$ being optimal for detection. The false positive rate at 1.4 GHz has been shown to be extremely low (Frail et al. 2012) and, in any case, the radio spectrum and characteristic timescale of a BNS merger afterglow is unlike that associated with possible contaminant events, such as radio supernovae afterglows. This is in contrast to the optical sky where counterparts to BNS mergers may be overwhelmed by false positives at the required depth of 22nd-23rd magnitude (Nissanke et al. 2013).

3 Galactic Radio Transients

Galactic radio transients ($> 1\,\mathrm{s}$ time scales) constitute an entirely distinct population to extragalactic radio transients, in terms of luminosity, progenitor population and time scale, some of which are preferentially clustered on the Galactic plane and some of which are effectively isotropic on the sky (eg. flare stars, brown dwarfs). The potential inclusion of commensal observing with the VLITE/LOBO system (< 500 MHz) is particularly advantageous in the search for Galactic transients, as there are known populations of transient sources previously detected in blinds surveys at 330 MHz.

3.1 Galactic Center Radio Transients

Blind surveys of the Galactic Center region with the VLA have been used to search for radio transients with a considerable degree of success (Hyman et al. 2002, 2005, 2009)[Figure 2]. Most notably, a blind search program using the Very Large Array (VLA) at 330 MHz (90 cm) identified a mysterious, bright, pulsing source towards the Galactic Center inconsistent with any known class of radio source, labeled GCRT J1745-3009 (Hyman et al. 2005). 100% circularly polarized 1 Jy bursts of duration ten minutes each, reoccurring with period of 77 minutes, were detected in a 7 hours of VLA data taken in September 2002. In multiple follow-up observations, the transient was detected in two more epochs of observations with the Giant Metre-Wave Radio Telescope (GMRT) in 2003 and 2004, with flux levels greatly reduced relative to the original detection. At the last known epoch of emission detected in 2004, the source exhibited an unusually steep spectrum with $\alpha = -13 \pm 3$ ($S(\nu) \propto \nu^{\alpha}$) (Hyman et al. 2009). Very high circular polarization has also been reported (Roy et al. 2010). GCRT J1745-3009 may be as close as 180 pc to the Galactic Center but limits on distance, and thus brightness temperature, are otherwise weak. For distances d $>$ 70 pc from the Earth, the radio flux density constrains its brightness temperature to exceed the limit for incoherent synchrotron radiation (Readhead 1994) thus requiring a coherent emission mechanism. The high circular polarization, spectral characteristics and intrinsic beaming of the emission support the assertion of coherent radio emission for this new class of radio source, christened "burper" (Kulkarni & Phinney 2005). We note that the 100% circularly polarized nature of the bursts from GCRT J1745-3009 favors par-

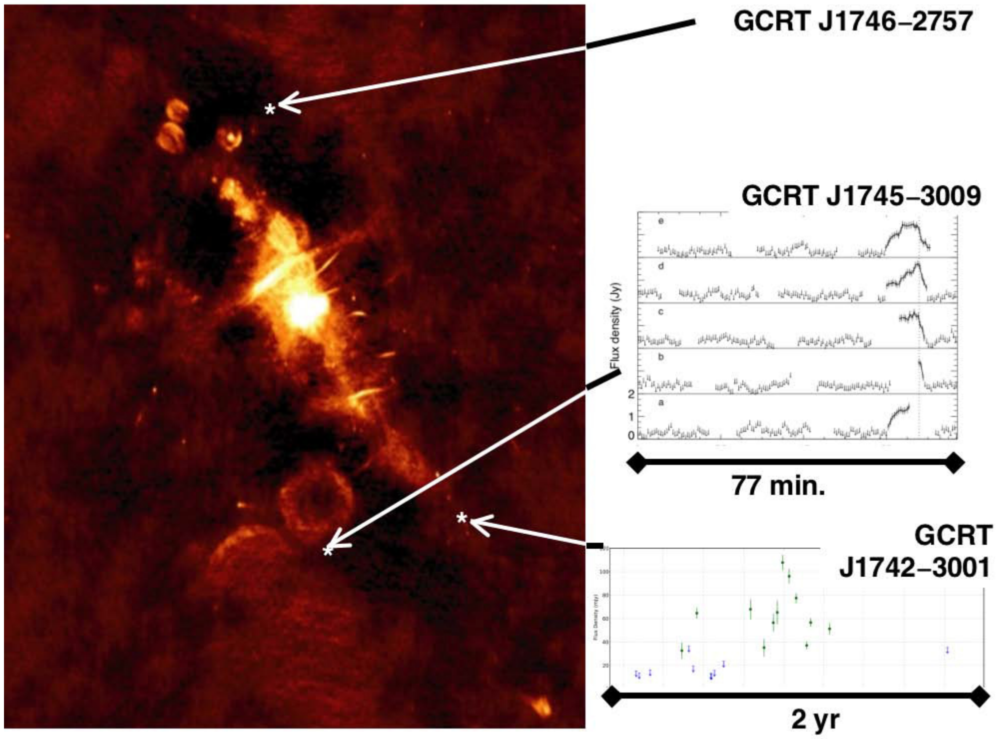

Figure 2. The diversity of the light curves for transients toward the Galactic center (Hyman et al. 2002,2005,2009]. The transient GCRT J1745-3009 burst several times (duration ∼10 minutes) during a 6-hr observation, with subsequent bursts detected over the next 1.5 yr; GCRT J1742-3001 brightened and faded over several months, preceded 6 months earlier by intermittent bursts; and GCRT J1746-2757 was detected in only a single epoch. None of these objects has been identified nor has a multi-wavelength counterpart been found. The background image is the Galactic center at 330 MHz. Figure taken from Lazio et al. (2009).

allel searches for transients in Stokes V where the galactic contribution will be reduced by many orders of magnitude relative to unpolarized Stokes I images.

No counterpart was identified in observations at other wavelengths, largely due to the poor localization of the position of the transient in radio data. It remains unclear whether GCRT J1745-3009 is intrinsically close to the Galactic Center or rather simply lies in the direction of the Galactic Center; the latter case being feasible due to the biased nature of the survey, for which blind searches for transients were restricted to the Galactic Center. Proposed counterparts include a nulling pulsar (Kulkarni & Phinney 2005), a double pulsar (Turolla et al. 2005), a transient white dwarf pulsar (Zhang & Gil 2005), a precessing radio pulsar (Zhu & Xu 2006) or a nearby pulsing brown dwarf or low mass flare star (Hallinan et al. 2007).

A second Galactic Center radio transient source (GCRT J1742-3001) was detected in multiple epochs of a 235 MHz transient monitoring program with the GMRT in 2006 and 2007 (Hyman et al. 2007). This was a very different class of radio transient, observed to brighten over a period of a month to a maximum of 100 mJy before fading in the subsequent 6 months. Once again, a very steep spectrum (< -2) was inferred. Discovering the frequency, nature and progenitors of these new classes of radio transients will open up new population of exotic objects to astrophysical study with the possibility of such transients being due to previously undetected populations of neutron stars being a particularly exciting possibility. The detection of two new classes of transient in very limited blind searches towards the Galactic Center speaks to the huge potential for discovery associated with monitoring this region of the sky. The VLASS will easily probe much deeper than any previous Galactic Center transient surveys. In particular, considering the steep negative spectrum confirmed for GCRT J1745-3009 and GCRT J1742-3001, the possible inclusion of VLITE/LOBO will be key to probing these particular populations as results from previous surveys suggest that the rate of detected transients would be ~ 0.2/hr with the upgraded VLA (Hyman et al. 2009).

3.2 Active Stars

Many classes of stars produce flares that are several orders of magnitude more luminous and frequent than any produced on the Sun, including young stellar objects, active M dwarfs and certain classes of tight binaries (eg. RS CVn systems). Such activity dominates the star's output over much of the electromagnetic spectrum, governs its angular momentum evolution and can also have a profound impact on the planetary systems orbiting such stars. In the latter case, higher X-ray and ultraviolet irradiation can lead to heating of the upper planetary atmosphere, resulting in photochemical reactions leading to significant atmospheric loss. In particular, studies of terrestrial planets in the habitable zone of M dwarfs, possibly the most abundant Earth-like planets in the solar neighborhood (Dressing et al. 2013), suggest that large flares and CMEs may potentially lead to catastrophic loss of the atmosphere of such planets (Khodachenko et al 2007; Lammer et al. 2007).

Radio bursts are a powerful means to detect and characterize flares and CMEs on the Sun and studies of radio bursts from nearby active stars can be similarly used to probe the local environment of impulsive flare and CME events with the potential for groundbreaking insight into the bulk motion of plasma in stellar coronae. Extremely bright bursts up to 1 Jy (Lovell et al. 1963) have been detected for decades from nearby M dwarfs, at luminosities that are up to 5 orders of magnitude more intense than any equivalent solar bursts. In more recent years, dynamic spectroscopy of stellar radio bursts has been carried out using the Very Large Array (VLA), Effelsberg, Jodrell Bank and Arecibo radio observatories(Bastian & Bookbinder 1987; Gudel et al. 1989; Bastian et al. 1990; Osten & Bastian 2006). In the case of the detected stellar radio bursts, the luminosities are orders of magnitude brighter than anything detected from the Sun, highlighting that the coronae possessed by active stars are very different to the solar corona. The radio emission properties clearly indicate coherent processes, probably associated with plasma radiation or electron cyclotron maser emission, the former providing direct measurement of plasma densities and the latter direct measurement of magnetic field strengths, while broadband dynamic spectra of bursts provide information of the size and extent of the associated stellar coronae. Studying the coronae of such active stars provides a laboratory to investigate physical regimes unavailable with spatially detailed studies of our low-activity Sun. Furthermore, such bursts potentially provide direct insight on the density, velocity and energetics of mass ejection from stellar coronae and the associated impact on planetary atmospheres.

Active stars also produce large incoherent flares (Osten et al 2005), due to gyrosynchrotron radiation associated with the same nature of magnetic reconnection events that produce bright coherent bursts. Insufficient data exists on the relationship between the incoherent and coherent flare emission, but this can be probed by the VLASS and VLITE/LOBO with the former probing the higher frequency incoherent emission and the latter probing the coherent emission more frequently confined to lower frequencies. The degree of circular polarization is often a good distinguishing characteristic between the incoherent and coherent emission. The expected rate for both incoherent and coherent flares in blind transient searches is poorly constrained, but will probed to unprecedented depth by VLASS.

3.3 Brown Dwarfs

A dozen or so low mass stars and brown dwarfs have been found to be radio sources in the last decade (Antonova et al. 2013 and references therein). A subset of these objects have been the subject of lengthy follow-up campaigns that have revealed the presence of 100% circularly polarized, periodic pulses, with the pulse period typically 2-3 hours and consistent with rotation (Hallinan et al. 2006, 2007, 2008; Berger 2009). This radio emission is thought to be electron cyclotron emission produced at the electron cyclotron frequency, in the same fashion as that detected from the auroral regions of the magnetized planets in our solar system. As is the case for such planets, it enables very accurate measurement of magnetic field strengths and rotation periods and has led to the confirmation of kilogauss magnetic fields in large-scale configurations for ultracool dwarfs. Indeed, radio observations have been the only method thus far capable of direct magnetic field measurements for L dwarfs; Zeeman broadening measurements are inhibited by the difficulty in obtaining high resolution spectra of these cool, dim objects (Reiners & Basri 2007).

Most recently Route & Wolszczan (2012) found the coolest radio brown dwarf yet detected, with the detection of radio pulses from the 900K T6.5 dwarf, 2MASS J10475385+2124234. Individual pulses were detected from this object in multiple short duration observations with the Arecibo observatory, resulting in a confirmed magnetic field strength of at least 1.7 kG near the surface of this extremely cool object. This significant discovery highlights the unparalleled diagnostic potential of radio observations of brown dwarfs, and their importance in constraining dynamo theory in the mass gap between planets and stars. The VLASS will be the first survey with the depth to blindly detect brown dwarfs in both quiescence and outburst.

4 Survey Strategy

The challenge faced in characterizing the extragalactic radio transient population is summarized in Figure 1, reproduced from Frail et al. 2012, which shows the expected areal density of extragalactic explosive transients as a function of peak flux density at 1.4 GHz and the associated characteristic time scales and luminosities. A single survey of the radio sky by the VLASS will detect a vast population of radio transients. However, those transients have associated rise times from weeks to years, depending on the nature of the associated cataclysmic event. Thus, the challenges thereafter are two-fold. 1) The transient must be identified as a radio transient. The optimal identification of a transient requires a deep reference image from an epoch prior to the image in which that transient was detected with the separation between each epoch being greater than the typical rise time for this class of transient. 2) The transient must be classified. This can only be achieved through a broadband radio spectrum (what frequency does the transient become optically thick?), as well as association with, and localization within, a host galaxy of known distance (how luminous is the transient and is it associated with a galactic nucleus?).

Galactic radio transients (> 1 s time scales) constitute an entirely distinct population to extragalactic radio transients, in terms of luminosity, progenitor population and time scale. The latter in particular demands a completely alternate strategy to fully sample the relevant time scales. With these challenges in mind, we consider two alternative strategies for the VLASS that enable transient science; a large two-epoch NVSS-style 30,000 deg^2 survey and a multi-epoch, multi-frequency, medium-area 1,000 deg^2 of the Galactic Gap and Galactic Plane. In both cases we use the "Capabilities of the Jansky VLA for Sky Surveys" paper by Steven Myers for estimating survey speed.

4.1 30,000 deg^2 2-epoch survey

Here we assume that the VLASS will survey the entire sky at $\delta \geq -40°$ at either 1-2 GHz or 2-4 GHz, the former requiring 217,446 mosaicked images, as was the case for the NVSS (Condon et al. 1998), and the latter requiring 869,784 mosaicked images. A survey of targeted pointings involves additional overhead due to move time plus dwell time, which leads to prohibitively poor observing efficiency for frequencies higher than L band. Thus we assume that the VLASS be carried out using on-the-fly (OTF) mosaicking, whereby the dishes slew continuously to survey an area with the phase centers being stepped for correlation. This allows the VLA to conduct a shallow survey while maintaining a high observing efficiency. This capability has been commissioned and tested on the upgraded VLA by members of our group and would allow the VLASS to be used for transient science without significantly impacting the observing efficiency.

The 2-epoch VLASS, if optimally scheduled, can provide an instantaneous snapshot of the radio transient sky. We recommend as large a separation between epochs as is feasible to allow complete capture of transients on all timescales. A 2-epoch, 2-4 GHz survey (100 μJy per epoch), with separation of 2 configuration cycles (32 months), for example, would almost fully capture all known classes of extragalactic transients with peak flux levels of 1 mJy or greater. Such a survey, with total observing time $<$ 4000 hours, would enable the following transient science:

1 Establishing the all-sky rate of known and unknown classes of transients at the $\sim$ 1 mJy level, both extragalactic and Galactic.

2 Determination of the rate and inverse beaming fraction of GRBs and TDEs.

3 Determination of the rate of obscured SNe in the local Universe.

4 Determination of the rate of binary neutron star mergers.

5 Production of a deep reference image with 70 μJy RMS noise of the entire sky for $\delta \geq -40°$ prior to the aLIGO and AdV era to enable triggered VLA follow-up of candidate binary neutron star merger events to the detection horizon of these gravitational wave detectors.

4.2 1,000 deg^2 multi-epoch survey

Here we assume that the VLASS will survey a fraction of the Galactic Plane and Northern Galactic Cap at one or multiple frequencies below 10 GHz covering a total combined area of 1000 deg^2. One possible strategy would be to survey at two frequencies (e.g. 2-4 GHz and 8-10 GHz) for multiple epochs, with each epoch reaching 100 μJy in both bands. This would take $\sim$ 400 hours per epoch, thus allowing multiple epochs at each frequency spaced to sample a range of timescales from weeks to years. Multiple epochs could be scheduled within a single semester as well as in semesters separated by a configuration cycle. Assuming a similar survey allocation of 4000 hours, this survey would enable the following transient science:

1 Establishing the areal rate and time scales of known and unknown classes of extragalactic and Galactic transients at both 2-4 GHz and 8-12 GHz (as ell as $<$ 500 MHz with VLITE/LOBO). We note that most classes of extragalactic radio transients will evolve over much shorter time scales in the 8-12 GHz.

2 Determination of the rate and inverse beaming fraction of GRBs and TDEs.

3 Determination of the rate of obscured SNe in the local Universe.

4 Determination of the rate of binary neutron star mergers.

5 Establishing the rate and time scale of Galactic Center radio transients.

The multi-frequency, multi-epoch medium-area survey offers some distinct advantages over the large two-epoch 30,000 deg^2 survey, particularly allowing the relevant (shorter) timescales for Galactic transients to be probed. However, the 30,000 deg^2 survey has the critical advantage of providing a reference image for triggered follow-up of aLIGO and AdV events. Furthermore, the wider shallow survey probes a much closer progenitor population and larger volume than the multi-epoch survey. In both cases, the addition of VLITE/LOBO is a critical advantage, the presence of which would certainly favor repeated mapping of the Galactic Center region. We note that a wider shallow survey for transient science may, of course, be at odds with other science from the VLASS.

5 Real-time Data Processing and Transient Follow-up

Rapid follow-up of VLASS transients, both with the VLA and VLBA at radio wavelengths and external facilities at optical and higher energies, is essential to maximizing the scientific return from transient science in the VLASS. Follow-up VLA observations establish the broadband spectrum of the detected radio transient and are is essential for classification. Meanwhile, the VLBA can place constraints on the size and location within a host galaxy of a transient. Both efforts will require accompanying VLA and VLBA programs for transient follow-up in the VLASS. Optical, infrared and X-ray observations establish the distance of the host galaxy, and in some cases may reveal a higher energy counterpart to the transient event. Once again, coordinated programs for follow-up in the optical, infrared and X-ray should be prepared in advance of the VLASS.

Processing of the VLASS data in near real-time is a significant task. The use of on-the-fly mosaicking requires images to be generated at every phase step, typically only a few seconds. Our group has developed custom pipelines to remove RFI, calibrate data, image data, produce mosaics and extract source catalogs for ongoing VLA surveys for radio transients in the SDSS Stripe 82 equatorial strip. Extending these pipelines to VLASS is relatively straightforward, albeit requiring the deployment of a dedicated $\sim$ 10-node cluster (assuming 2014 Haswell CPUs) attached to the Lustre high-speed file system at the NRAO DSOC in Socorro.

6 Summary and Conclusions

The VLASS has the potential to be transformational for radio transient studies. The use of OTF-mosaicking allows the the VLASS to be conducted over multiple epochs, enabling transient science, without severely impacting the final combined dataset used continuum or spectral line mapping. The use of dedicated hardware and near real-time data reduction is essential to rapid follow-up, but existing demonstrations of these capabilities are already in place.

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