# Presentation Abstracts

## Morning Oral Presentation Section

### Investigating the importance of magnetic fields in low- and high-mass star forming cores

*Dr. Eswaraiah Chakali, NAOC*

Stars form via gravitational collapse of dense molecular clouds. In the absence of any counteracting forces against gravity, star-formation rate could have been extremely high, forming 100's of stars every year. However, the observed star formation rate in our Milky-Way Galaxy is inefficient about 2 $M_{sun}$/yr. It has been shown that, in addition to gravity, the magnetic fields (B-fields), turbulence, and stellar feedback, are the key drivers, govern the star formation processes. These include accumulation of material from low-density diffuse interstellar medium (ISM) to dense molecular clouds, further fragmentation of filaments into dense cores, and star-formation in them. However, the relative importance of B-fields to other parameters is poorly constrained. In addition, existing polarization data in optical, near-infrared, and low-resolution sub-mm (by Planck) wavelengths is limited to the low-density parts of the molecular clouds. However, B-fields at the scales and densities of the dense cores remain poorly explored. This is mainly due to the lack of more sensitive observations, requirement of substantial amount of telescope time, and faintness of the sources. Here, we present the results based on the high resolution and sensitive dust polarization observations, from JCMT SCUBA2-POL2, towards the clumps and cores located in the environments of varying star-formation activity. B-fields are found to be compressed and their strength has been enhanced in the dense clumps formed at the waist of bipolar HII region. Based on the comparisons among magnetic, turbulent, thermal, and gravitational energies, we infer that strong B-fields found to influence the expanding I-fronts, reduce the shock strengths as well as the level of turbulence, shield the clumps from erosion, and support the clumps against gravitational collapse. In an another study, as a part of BISTRO program, we have performed the most sensitive, deep, and high resolution dust polarization observations towards Sun-type star forming cores located in Taurus/B213. We have successfully detected weakly polarized dust emission. We found that B-fields in the cores ($< 0.1$ pc) are decoupled from the large scale ordered B-fields. We show that, in comparison to B-fields, other parameters such as gravity, core rotation, gas kinematics, etc could be important in the cores of B213.

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### An Exploration of How Training Set Composition Bias in Machine Learning Affects Identifying Rare Objects

*Dr. Sean E. Lake, NAOC*

When training a machine learning classifier on data where one of the classes is intrinsically rare, the classifier will often assign too few sources to the rare class. To address this, it is common to up-weight the examples of the rare class to ensure it isn't ignored. It is also a frequent practice to train on restricted data where the balance of source types is closer to equal for the same reason. Here we show that these practices can bias the model toward over-assigning sources to the rare class. We also explore how to detect when training data bias has had a statistically significant impact on the trained model's predictions, and how to reduce the bias's impact. While the magnitude of the impact of the techniques developed here will vary will the details of the application, for most cases it should be modest. In radio surveys such as CRAFTS, for example, they should prove invaluable in the accurate identification and characterization of strange objects, like blazars. In the particular case of the FAST surveys, we intend to implement them in a source characterizing tool called FASTView. They are, however, universally applicable to every time a machine learning classification model is used, making them analogous to Bessel's correction to the sample variance (using $N - 1$ to calculate the variance instead of N).

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## Fast Observations of the HI Narrow Self-absorption Zeeman Effect

*Dr. Tao-Chung Ching, NAOC*

We present the first clear evidence of the evolving magnetic field in the center of quiescent dark molecular clouds. The strength of the B field was derived from the Zeeman signature of the HI narrow self-absorption (HINSA) feature. HINSA zeeman measurements have crucial advantages over the more common spectral traces, such as OH that is predicted to disappear in dense gas due to chemical evolution and CN that tends to suffer depletion. The combined analysis of both OH and HINSA Zeeman measurements reveal an evolving B field, losing strength from outside-in, consistent with the classical ambipolar diffusion mechanism, which has long been proposed, but rarely corroborated by observations. Our observation and analysis thus support a relatively long time scale for star formation, due to the requirement to dissipate magnetic support.

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## The new FRBs found in FAST drift scan

*Dr. Chenhui Niu, NAOC*

FAST Drift Scan Survey uses all 19 beams and 500 MHz bandwidth from 1 GHz to 1.5 GHz. It has 4096 frequency channels with 96 or 196.68 μs time resolution. A Pipeline based on Heimdall is build to explore the FRBs from FAST Drift Scan Survey. This Pipeline is called FAST Miner which can schedule 21 GPU servers work simultaneously. After completing the search from June 2018 to October 2019, 5 New FRB candidates were Found. It is worth noting that one of the 5 FRB candidates has been observed 4 pulses.

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## Southern Pulsar Census and Polarimetric Studies with the MWA

*Ms. Mengyao Xue, NAOC/Curtin University*

The Murchison Widefield Array (MWA) provides an excellent opportunity to extend the frequency range of pulsar observations in the Southern Hemisphere. In 2017, we carried out an initial census of a large sample of known (i.e., catalogued) pulsars at 185 MHz using the MWA Voltage Capture System (VCS). This led to the successful detection of 65 pulsars (including six millisecond pulsars and two in binary system), but using only ~10% of the full-array sensitivity, as the detected powers from the tiles were incoherently summed. In order to achieve the full-array sensitivity, a new tied-array (i.e. phased array) beam-former pipeline has been developed. Verification of the polarimetric performance of the MWA in the tied-array mode is required before we can use this new capability for pulsar science. Using two bright southern pulsars, PSR J0742-2822 (moderately polarised) and PSR J1752-2806 (highly polarised), we did a detailed characterisation of the polarimetric performance empirically. The result suggests that reliable pulsar polarimetry can be realised at frequencies < 270 MHz, and at zenith angles < 45 degrees. This analysis also led to first low-frequency polarimetric studies of these two southern pulsars, high-precision determinations of their Faraday rotation measurements, and an intriguing result, where the degree of linear polarisation of one of the pulsars, PSR J0742-2822, showing a steady (and rapid) decline at the low frequencies of the MWA, which is in contrast with the generally expected trend for pulsar emission. Motivated by this intriguing result, we undertook further analysis of de-polarisation in the low-frequency observations of multiple pulsars in the general direction of the Gum Nebula, including the well-known Vela pulsar, PSR J0835-4510, whose radiation possibly traverse through part of the nebular material. I will present the related analysis and new results, as well as our current interpretation in the context of magneto-ionic turbulent ISM in the general direction of the nebula.

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## **Interstellar scintillation and 3D spin-velocity alignment in the PSR J0538+2817/SNR S147 system**

*Dr. Jumei Yao, NAOC/XAO*

High sensitivity interstellar scintillation and polarization observations made using the Five-hundred-meter Aperture Spherical radio Telescope (FAST) show that the shell of supernova remnant (SNR) S147 dominates the scattering of PSR J0538+2817 and provide evidence for three-dimensional alignment of the pulsar spin axis and space velocity. Based on the dynamic spectra in two bands centered at 1100 MHz and 1400 MHz respectively, we find that the slope of the structure functions of the intensity variations are consistent with a Kolmogorov spectrum for the scattering density fluctuations. These secondary spectra show a strong parabolic arc, with the arc curvature implying that the scattering screen is located only 33.4±9.5 pc from PSR J0538+2817. This is consistent with the scattering occurring in the shell of S147, thereby confirming the association. The observed scattering also gives evidence that the pulsar is located inside the SNR shell. We also observe a significant asymmetry in the arc, implying a small refractive angular deviation of the scattered rays that persists over the 1-hr observation. With the assumptions that the scattering is dominated by the SNR shell and the shell is spherical, we derive the inclination angle of the pulsar velocity from our line of sight, $\zeta_v$= $108.^\circ1\pm18.^\circ3$, which is not only consistent with the inclination of the spin axis $\zeta_{pol}$= $118.^\circ5\pm2.^\circ3$ which we derive from FAST pulse polarization observations, but also close to the inclination angle $\zeta_X$= $100^\circ \pm 6^\circ$derived from X-ray observations of the pulsar wind nebula. This is the first observational evidence for alignment in three dimensions of a pulsar velocity and its spin axis.

# Afternoon Oral Presentation Section

## The potential of detecting radio-flaring ultracool dwarfs at L band in the FAST Drift-Scan Survey

*Dr. Jing Tang, NAOC*

The Five-hundred-meter Aperture Spherical radio Telescope (FAST) has completed its commissioning and will begin the Commensal Radio Astronomy FasT Survey (CRAFTS) in 2020. We present predictions for the number of radio-flaring ultracool dwarfs (UCDs) that are likely to be detected by CRAFTS. Based on the observed flaring events from a number of UCD-targeted radio surveys in the literature, we derive a lower limit of ~3% as the detection rate of flaring UCDs. With an assumption of a flat radio spectrum in $\nu L_\nu$ for UCD flares, we construct a flare radio luminosity function (LF) to be $dN/dL \propto L^{-1.28 \pm 0.16}$. We find that CRAFTS is capable of detecting flares from UCDs up to ~260 pc, comparable to their scale height in the Galactic thin disk. Using the Monte Carlo simulation with the consideration of 3-D spatial distribution of these dwarfs, we find that in the planned two-pass CRAFTS observations, ~160 flaring UCDs would be detected as transients when taking ~1.7% as the average flare duty cycle and assuming a flat $\nu L_\nu$ at 1–10 GHz. The result is marginally sensitive to the scale height of UCDs, but very sensitive to detectable flaring UCD ratio and the assumption of the spectral index at low frequencies (~1.25 GHz). When the radio spectral index varies from 0.0 to -2.0, the expected detection number would increase dramatically from ~20 to ~1830. Also we discuss the refined selection criteria for the flaring UCD candidates for follow-up observations to optimize the limited telescope resources.

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## The prediction for the future CRAFTS extra-galactic HI survey

*Mr. Zhang Kai, NAOC*

The Five-hundred-meter Aperture Spherical radio Telescope (FAST) has made striking progress in its commissioning stage and now is in preparation for the Commensal Radio Astronomy FasT Survey (CRAFTS). In this talk, I’ll introduce the technical parameters of FAST derived from the commissioning observations and predict the future CRAFTS extra-galactic survey on galaxy detection and HI Mass Function (HIMF) measurements from mock catalogues. Our results suggest that 2-pass CRAFTS extra-galactic HI survey will be able to detect nearly $4.8\times10^5$ galaxies with a mean redshift of 0.055, from which the “faint end” slope of the HI Mass Function (HIMF) can be recovered to

$10^7$ $M_{solar}$ and the “knee mass” of the HIMF can be measured to a redshift of 0.1. However, source confusion will be a non-trivial problem for a single-dish telescope like FAST. After including the source confusion effect, the measured HIMF deduced from the Semi-analytic simulation will be biased within 2 sigma Poisson error within a redshift of 0.1. Considering the RFI status and sensitivity limitation, CRAFTS will be efficient in detecting HI galaxies at redshifts below 0.1, which implies a tremendous potential in exploring the galaxy interactions in different environments and the spatial distribution of HI galaxies in the local universe.

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### The study of inter-arm clouds in M31

*Mr. Sihan Jiao, NAOC*

From our deep M31 JCMT/SCUBA2 850 um map, we identify a large number of cold compact (< 54 pc in diameter) molecular clouds in the intra-arm and inter-arm regions, of which the inferred gas masses from dust emission range from $3\times10^4$ $M_\odot$ to $10^7$ $M_\odot$. Those on-arm clouds in M31 may be analogous to the GMCs in the Milky Way (e.g., W49 A, G 10.6-0.4) based on their masses and other properties, while what are these colder inter-arm clouds are largely unknown before our survey. Such cold inter-arm clouds is also identified in M33. For better understanding what are these inter-arm clouds and what is their origin, we took a series of follow-up lines observations, and found they are cold, they are at GMC scale (10-30 pc), their mass is slightly less than on-arm GMCs, there linewidth is narrow. Were they migrated from arms or were they formed locally? Understanding the origin and evolution of these inter-arm clouds/GMCs may shed light on the fundamental picture of how GMCs are formed and destructed. For trying to answer this question, we are proposing to use CO line to identify the velocities of a serious inter-arm clouds, from where we can tell if these velocities are consistent to a real physical cloud flow.

# Poster Presentations:

## From Carl Sagan to Kardashev

*Prof. Di Li, NAOC*

I’d like to present our recent testing results from FAST SETI backend. I quantify FAST’s reach in SETI based on the equivalent isotropic radiation power (EIRP). Equipped with a dedicated pipeline and its world-leading instantaneous gain, FAST will be able to detect human-like transmitters on TESS planets and any Kardashev type II or more advanced civilizations in the Andromeda galaxy.

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## A Study of the Co-existence of Outflow and Bubble

*Ms. Yan Duan, NAOC*

We have found a new molecular bubble in the Taurus B18 cloud in our CO map. A previous identified outflow is located at the center of the bubble (Li et al. 2015) and they are coincident in velocity. Also, Herbig–Haro 319 is located at the same center produced by the outflow, holding the important clues of the origin of the bubble. The strong CO emission, the extremely high energy injection, the peculiarity of this structure and the location of the outflow cloud make a great interest to study the origin and evolution of the stellar feedback activity.

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## From Carl Sagan to Kardashev

*Mr. Hongfeng Wang, CAS KLFAST*

Radio frequency interference (RFI) is an important challenge in radio astronomy. It comes from various sources and increasingly impact astronomical observation as telescope getting more sensitive. In this study, we propose a fast and effective method for removing RFI in pulsar data. We use pseudo-inverse learning to train a single hidden layer auto-encoder (AE). We demonstrate that the AE can quickly learn the RFI signatures and remove them from fast-sampled spectra, leaving real pulsar signals. This method has the advantage over traditional threshold-based filter method in that it does not completely remove contaminated channels, which could also contain useful astronomical information.

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## A RECIPE FOR DERIVING KINETIC TEMPERATURE FROM AMMONIA INVERSION LINES

*Mr. Shen Wang, NAOC*

Ammonia is a classical interstellar thermometer. The previous methods for estimating the rotational and kinetic temperatures are largely affected by blended hyperfine components (HFCs). We developed a new reliable recipe, referred to as the hyperfine group ratio (HFGR), which utilizes only direct observables, namely the intensity ratios between the grouped HFCs. From the simulated spectra, we show that the rotational temperature Trot can be unambiguously derived from the HFC intensity ratios using a set of empirical formulae. Compared to classical methods, the current recipe has two major advantages. Firstly, the Trot calculation is based on empirical formulae instead of fitting for optimized physical parameters of Trot, line width ΔV, and the NH3 optical depth. Secondly, the calculations only involve the integrated intensities of the HFC groups thus does not require modeling the HFC and fitting the line profiles. And the blended HFCs would no longer undermine the accuracy of Trot.

Consequently, the computational load can be reduced to a very small amount ($\sim 10^{-4}$)) compared to the complete spectral fitting. In the meantime, HFGR maintains the accuracy of better than 0.15 K over a broad temperature range of 10 to 70 K. The simplicity of HFGR makes it orders of magnitude faster than the classical methods and more robust against noise and HFC blending.

## A Joint Study with FAST and Parkes for PSR J1926-0652

*Ms. Lei Zhang, NAOC*

PSR J1926−0652, a pulsar recently discovered with the Five-hundred-meter Aperture Spherical radio Telescope (FAST). Using sensitive single-pulse detections from FAST and long-term timing observations from the Parkes 64 m radio telescope.