OzSKA
Summary of Discussion Groups
Wednesday, 8 April

Cosmology **Chris Blake**

- General concern about how the removal of SKA1-survey affects the potential for large-scale extragalactic surveys with SKA phase 1. How well suited is the SKA1-mid configuration to survey science?
- Need to maintain connection to simulations and theory. Seriously under-represented at this conference, radio astronomy community is very observations-dominated?
- Intensity mapping should be the most interesting cosmology goal, but worries over calibration schemes for the auto-correlations, baseline distribution of SKA1-mid, lot of effort still needed to deal with foregrounds, polarization leakage.
- New gravitational lensing techniques in the radio could be very interesting.
- Cross-correlations between radio continuum surveys and CMB / CMB lensing / low-z optical surveys are all solid science but in what circumstances is it competitive with other cosmological probes?

EOR /Cosmic Dawn **Cath Trott**

- conversation centred around resourcing of EoR/CD science within Australia, and attracting additional students and researchers to contribute knowledge to the EoR effort beyond the MWA EoR group
- discussion around inserting learnings from the MWA into the design and execution of SKA-Low and the EoR/CD experiments, and having a more formal Australian management structure to communicate with the SKA Office
- instrument flexibility will allow for a higher likelihood of success, particularly with reference to including a drift scan mode for EoR observations
- potential for Australian involvement in one of the two primary KSPs for EoR/CD (imaging and power spectrum). Model includes two KSPs with significant personnel overlap and sharing of learnings
- increase the contribution of Australian astronomers to the SWG.

Magnetism & Milky Way **Emil Lenc**
Simon Ellingsen, Chris Herron, Cormac Purcell, Xiaohui Sun
What is the key science planned for SKA1?
- High resolution RM grid.
- RM tomography of nearby galaxies.
- Galactic structure (masers, t-Tauri stars and other compact objects)
What are the synergies with other wavelengths?
- Magnetic tomography of spiral arms.
- Ties in with distance measurements and HI galactic work.
- - Tells us about galactic structure.
- - Understand relationship with star formation.
- Infrared colours

- H-alpha - dust polarisation
Are these links in place?
- Yes, for EMU … unclear with respect to SKA1
Where does Australia have critical mass (research-wise)?
- Australia has lost some of its research capacity in polarisation (dispersed, depolarised?).
Leadership potential?
- Plenty (big hole left behind with departure of key people in polarisation).
Is there potential science that has been missed by the written science cases – how well developed is it – is there work to be done?
- No diffuse polarisation in POSSUM or SKA1 - turbulence.
- POSSUM will be contaminated by diffuse polarisation.
Have you considered developing new science interests over the next 5 years?
- The overall concensus was that we do this all the time.
What is the most exciting science that you think should be pursued by SKA1?
- intrinsic polarisation properties of targeted sources at high angular resolution - feeds back into our interpretation of wide field polarimetric studies (star forming galaxies and AGN).

Transients & Pulsars incl Strong tests of gravity Ramesh Bhat

- The discussion focused on 3 topics revolving around the major science drivers: timing arrays, pulsar searches, and FRBs

- **Pulsar Timing Arrays**: an area in which Australia has been leading the world, with the best limit on the strength of GW background and extensive instrumentation experience.
    - SKA-Mid is 8 x collecting area than Parkes with twice the bandwidth, so should be quite competitive with the IPTA. Substantial time allocation for the pulsar timing project with MeerKAT (KSP led by Bailes), and Swinburne is building the timing backend for MeerKAT. Clearly this is an area we have the opportunity to lead.
    - Some concern over our ability to do effective DM correction if band 1 doesn't get built, (given its lower priority following rebaselining). This largely stems from a recent work that suggests measurements across an octave in frequency are optimal. The new ultra-wideband receiver at Parkes and the MWA (both spanning 2 to 3 octaves in frequency) provide us opportunities to investigate this in detail and develop suitable strategies for better DM correction – this can be hopefully achieved within the time line of SKA-low.

- **Pulsar searches**:
    - Not much going on within Australia in low-frequency pulsar searching, though targeted searches toward transient polarised sources to be found in MWA data might provide a new avenue. The

upper end of the SKA-low band might still be good to search for MSPs, given the GBT's success in finding MSPs toward Fermi-candidate fields. The European groups are obviously better positioned to lead this effort, with Australian involvement focusing on the timing follow-up of the new discoveries.

- **Fast radio bursts (FRBs)**: Australia has been spearheading much of the development in this field, having played the pioneering role in their discoveries. Molonglo is now coming up to speed and the MWA has begun shadowing Parkes.
    - Consensus on us continuing to play an important role in advancing this new area. There is going to be a transient buffer in some capacity for SKA1 though the details are not clear yet. It is important that this buffer keeps polarization information and enables localisation. Polarisation is also needed for imaging slow transients (e.g. stellar flares).
    - No low-frequency detections have been reported yet – we need to re-think the science case (particularly for SKA-low) if it turns out that the FRBs are not detectable at lower frequencies. With all the continuing effort at Parkes and Molonglo and shadowing with low-frequency arrays such as MWA and GMRT, we hope to be able to address this within the time line of SKA low.

Cradle of life: **Ian Morrison**

- We attempted a quick survey of current CoL activities across Australia:
    1. Protoplanetary disks: Swinburne
    2. Exoplanets: UNSW, USQ (mostly optical)
    3. SETI: Curtin/ICRAR (VLBI SETI), Swinburne (detection algorithms)
    4. Pre-biotic molecules: UNSW, ICRAR
    5. Star-cluster sub-structure: UTas (OH Masers)

    (list incomplete, but hopefully representative)

- It was quickly realised that most of Australia's CoL activity does not fit within these domains, but in a sixth domain not captured by the SKAO's science prioritisation process:

    6. Cloud and star formation: Curtin/ICRAR, CASS, UNSW, ANU, UWS, UTas, Adelaide
        - SKA1 can probe dynamics of ionised, atomic and molecular gas at high resolution; Zeeman measurements
        - Combination of SKA1 and ALMA: extragalactic HII region studies allow us to extrapolate from current Galactic HII region studies; 3D picture

of star formation across other galaxies; H2 volume density and cloud/star formation in the Milky Way

- Two areas were identified where Australia could provide leadership:
  1. Cloud and star formation – given the high level of activity in this domain;
  2. SETI – there are synergies with pulsar search/timing, where Australia is already a leading player.

Continuum surveys: Nick Seymour

SKA Key Science is Star Formation History officially, but can't disentangle from the general theme of galaxy evolution
•Good expertise already here in Australia, but little overlap with SKA Continuum SWG, need to get them engaged
•Key to science is to align with other multi-lambda deep surveys
•Accept science case will evolve, e.g. with EMU we keep generating new KSPs after we thought we'd exhausted ideas
•How do precursors feed into SKA: MWA/GLEAM and ASKAP/EMU will provide SKA with an all-sky model
•Match to simulations, something lacking in this area possible new KSP for EMU
•unexpected new class of objects from EMU/GLEAM
•Broad band radio science
•LOW quickly confused -> cover wide-lambda
•Need to get continuum from FLASH between MWA+EMU
•High-nu survey (300MHz) from eMWA
•Deep/Wide CX-band observation of the ATLAS survey fields

HI galaxies incl absorption: Virginia Kilborn

The following topics were discussed in the HI discussion group:
Outflows and absorbers (Morganti/Sadler) Allison/Curren
This science case is well-served by SKA-mid/ SKA-low. It was noted that sub-arcsecond resolution is important.
VLBI follow-up capability with SKA/ASKAP/PKS/ATCA would be very powerful
Band 1 very important for this science case (currently listed as 3rd priority band)
SKA-low: This telescope could also be used in absorption studies, and may offer the opportunity to study new objects (eg new population of quasars ?)
Galaxy and Magellanic Couds (McClure Griffiths)
Noted, but there was no-one in the room to talk to this science case.
Cosmic Web (Popping)
Deep observations (NHI< 10^18) preferably over a wide area are needed for this science case.
Galaxy Evolution (Blyth) and neutral ISM (de Blok)
Some of the science topics discussed by the group under this heading included:

- Cosmic evolution of HI
- Understanding of radio-mode feedback to higher-z and lower powers

- Basics of HI in galaxies – statistical, eg profiles, distributions, structure, outflows and enrichment – does the HI profile trace the outer parts of a galaxy ?
- Low-mass galaxies – crucial for galaxy formation models
- Accretion, environmental effects, resolved line-widths,
- Individual galaxies, how do stars form from gas clouds.
- Steve Curran: OH in the same band as HI emission (currently, although this would be lost if band 2 frequency change proposal is approved)

How does re-baselining affect these goals?
Lost some ability to push down the HIMF to high statistical accuracy
Wide-area surveys with ASKAP might be a possibility – but better resolution (~10") is vital for a lot of the science.
For the cosmic web science case – without SKA-survey, we will miss out on wide-area obs – ie, won't have wider environmental information. Might be able to get this through redshift space.
SKA-mid still excellent for individual galaxy studies.

Complementary multi-wavelength surveys
Whilst there are a number of optical surveys planned that will work well with the timescales of SKA-1, there will be less in terms of UV/IR available.