CTA-Australia : Consortium Workshop 8

Tuesday 23 April 2019 - Wednesday 24 April 2019

University of Sydney, School of Physics

Book of Abstracts

Contents

21

ALMA CO observations toward gamma-ray supernova remnants

Gamma-ray supernova remnants are thought to be primary accelerators of cosmic-ray protons up to knee energy. Over the last two decades, we have learned that interactions between SNR's shock waves and interstellar neutral gas play a key element in understanding the origin of cosmic-ray protons and their gamma-ray radiation (e.g., Fukui et al. 2003, 2012, 2017; Sano et al. 2017, 2019; Maxted et al. 2013, 2018). In this talk, I will present the latest ALMA CO results
toward the gamma-ray supernova remnants RXJ1713.7-3946, N132D, and gamma-ray superbubble 30 Doradus C.

19

Creating science from EMU and multi-messenger data

It has been said that there is nothing as useless as a radio
source. Certainly, the science is greatly magnified if the radio sources can be cross-identified with other multi-messenger catalogues such as CTA, and redshifts measured or estimated. But it is non-trivial to do so for the catalogues of tens of millions of sources that will be generated by
next-generation radio continuum surveys, especially since many of those sources are extended or contain multiple components, none of which may correspond to the optical host galaxy. In this talk I review recent developments, mainly using machine learning techniques, for radio source
cross-identification, classification, and redshift estimation, and outline the science, including the unexpected, that we may expect to result from them.

11

Dark Matter in the Local Group: Possibilities and Problems

The Local Group offers the best opportunity to trace the dark matter properties of galaxies, directly confronting our cosmological models. Whilst the dynamical evidence points to the presence of abundant dark matter throughout the Local Group, many of its apparent properties are in conflict with our understanding of galaxy evolution. In this talk, I will review our present knowledge, and point to the successes, and apparent problems, of dark matter in the local galactic environment.

26

Discussion Session 1

Corresponding Author(s): gavin.rowell@adelaide.edu.au

- CTA Consortium membership categories
- Future CTA funding
- CTA Linkages with optical/radio
- CTA Related Meetings
- Other projects in TeV gamma-ray astronomy
- Astroparticle physics in Australia

24

Early Cherenkov light studies at Uni Sydney and Narrabri

The Uni of Sydney has played a pioneering role in the development of air Cherenkov detection going back to the 1950's and leading to possibly the first TeV gamma-ray signal recorded from Cen-A in 1975. I'll present a brief look at these results.

5

Electroweak monopoles and prospects of their detection

Archil Kobakhidze[1]

[1] *The University of Sydney*

Corresponding Author(s): archil.kobakhidze@sydney.edu.au

I will argue that topologically stable particle-like objects, which can be described as electroweak monopoles, are the inevitable prediction of the minimal Standard Model. Furthermore, their existence provides new CP violating phases and new baryon number violating interactions in the Standard Model. These monopoles must have been produced non-thermally during the electroweak phase transition driving the phase transition out-of-equilibrium and generating cosmological asymmetry between matter and antimatter.

I will describe prospects of the monopole detection using direct Cherenkov light from relativistic monopoles or the Cherenkov light from secondary particles emitted in baryon number violating processes along the trajectory of slowly moving monopoles.

10

Extreme Variability of the M87 jet and its Very High Energy connection

The radio galaxy M87 has been experiencing repeated flaring and extreme variability during the last two decades triggering a worldwide effort to understand the nature of the flaring and
the very high energy emission emanating from this giant elliptical galaxy. After the detection of M87 as a VHE source, HESS, VERITAS, and MAGIC established coordinated monitoring campaigns and recorded strong flux variability. M87 has also been detected by the Fermi LAT at MeV/GeV energies,

with an average energy >100 MeV over 10 months of all-sky survey data. Possible sites for the VHE emitting region will be discussed.

12

Fast Radio Bursts - A Status Update

Fast Radio Bursts are extragalactic radio sources of 10s of microsecond to 10s millisecond durations. Thousands appear to occur daily to the sensitivity limit of the Parkes radio telescope, the facility that discovered them in 2007. After a decade of searching, the number of known FRBs is approaching 100 events, with their origins remaining obscure. Parkes has been joined in the hunt for FRBs by other facilities in Australia – in particular Molonglo and ASKAP, and elsewhere – eg MeerKat (South Africa), CHIME (Canada), DSA, Arecibo and GBT (USA), Westerbork/LOFAR (Netherlands), Effelsberg (Germany). Spectacular progress has been made in the last 3 months, with efforts to localise FRBs to host galaxies maturing rapidly, and sensitive wide area facilities yielding much higher discovery rates of FRBs. I will review the state of FRB search and characterisation programs at all ongoing and planned facilities, with a focus on the host galaxy localisation efforts at ASKAP and Molonglo.

7

ISM studies of the galactic centre region, supernova remnnants, and extreme stellar clusters.

Gavin Rowell[1] ; Rebecca Blackwell[2] ; Cameron Snoswell[None] ; Peter Marinos[None] ; Fabien Voisin[1]

[1] *University of Adelaide*

[2] *Uni Adelaide*

Corresponding Author(s): fabien.voisin@student.adelaide.edu.au, gavin.rowell@adelaide.edu.au

In this talk I will present an update on some key projects looking at the ISM towards TeV gamma-ray sources. A focus will be on the galactic centre region, the TeV-bright SNR RXJ1713.7-3946, the extreme stellar cluster Westerlund1 and supernova remnants in the LMC. I will also outline other longer term projects such as GALPROP modeling of the diffuse galactic gamma-ray emission, and how all of these projects will impact CTA's science.

23

Intensity Interferometry at Narrabri

18

Looking ahead with MeV gamma-rays: future mission synergies with CTA

MeV gamma-ray astronomy has given the astronomy community significant insights into the physical processes that underlie stellar nucleosynthesis, solar flares and cosmic ray propagation since the first instruments sensitive to MeV photons were developed during the 1960s. Modern space-based observatories such as the Compton Gamma-Ray Observatory and INTEGRAL have yielded the first

observations which are resolved both spatially and spectrally. When combined with observations of TeV gamma-rays, which can be made with much greater spatial resolution, high spectral-resolution MeV observations can give a unique opportunity to study the SED properties of objects such as blazers and pulsar wind nebulae. Australia has played an important part in many early observations of MeV gamma rays, with balloon-borne gamma-ray spectrometers flown frequently from Alice Springs. I will discuss proposed future missions which will continue the legacy of the Compton Gamma Ray Observatory and INTEGRAL, and the potential possibilities for collaboration and discovery between the MeV community and CTA, and prospects of Australian involvement in the MeV community

2

Looking for PeVatrons with CTA - The Milky Way's extreme accelerators

Gavin Rowell[1] ; Sabrina Einecke[2] ; Miroslav Filipovic[3]

[1] *University of Adelaide*

[2] *The University of Adelaide, Australia*

[3] *Western Sydney University*

Corresponding Author(s): gavin.rowell@adelaide.edu.au, m.filipovic@uws.edu.au, sabrina.einecke@adelaide.edu.au

A key science focus of CTA will be the search for the Milky Way's extreme accelerators, the so-called PeVatrons. These are astrophysical objects accelerating cosmic rays to PeV energies and beyond. The HESS Galactic Plane Survey has revealed a number of potential PeVatrons in addition to the inner Galactic Centre region. This talk will outline the CTA's potential to explore uncharted territory in the >50 TeV gamma-ray regime which will probe cosmic rays escaping their accelerator regions and interacting with the surrounding interstellar gas.

25

Neutrinos

6

Radio vs Gamma-rays: Update on our HESS vs. MWA project

Miroslav Filipovic[1] ; Natasha Hurley-Walker[2] ; Nigel Maxted[3] ; Gavin Rowell[4]

[1] *Western Sydney University*

[2] *Curtin University*

[3] *UNSW*

[4] *University of Adelaide*

Corresponding Author(s): m.filipovic@uws.edu.au

I will present update on our ongoing project where we compare our latest generation of HESS images with MWA. Specifically, I will highlight 4 papers that we have submitted in this area over the past few months. Several new Galactic SNRs have been discovered as well as several candidates are now confirmed.

16

The Cherenkov Telescope Array - Overview and Status

Sabrina Einecke[1]

[1] *The University of Adelaide, Australia*

Corresponding Author(s): sabrina.einecke@adelaide.edu.au

The Cherenkov Telescope Array is the next-generation observatory for ground- based gamma-ray astronomy. With more than 100 telescopes equipped with state- of-the-art technologies, it will provide a new view of the sky at energies between a few GeV and up to 300 TeV. This contribution will give an overview and status of the project and will inform about Australia's involvement in the project. It will also present synergies between CTA and other areas.

15

The Compact High-Energy Camera for the Cherenkov Telescope Array - Overview and Status

Sabrina Einecke[1]

[1] *The University of Adelaide, Australia*

Corresponding Author(s): sabrina.einecke@adelaide.edu.au

...

9

The Deeper, Wider, Faster program: Pioneering all-wavelength, multi-messenger fast transient exploration

I will discuss the history, structure and strategy behind our
all-wavelength, multi-messenger Deeper, Wider, Faster program (DWF) to detect and study transients with millisecond-to-hours duration in real time. Fast transients include events such as fast radio bursts (FRBs), supernova shock breakouts, gamma-ray bursts, Type Ia supernova collisions with companion stars, X-ray bursts, flare stars, blitzars, and kilonovae. DWF coordinates over 50 telescopes on every continent and in space, from radio through gamma-ray, organised with neutrino, cosmic ray, and gravitational wave detectors. The world's most sensitive, wide-field
telescopes are coordinated in all wavelengths to acquire fast-cadenced data, at the same time on the same fields, to detect fast transients and gather all possible information before they fade. The radio and high-energy facilities process and identify fast transients in real time on board or via
GPU clusters. Simultaneous fast-cadenced CTIO DECam and NAOJ Subaru HSC optical imaging is acquired and processes in real time (seconds) on the Swinburne supercomputer throughout the night. Optical candidates are
identified within minutes after outburst with the help from advanced software and data visualisation technology. The multi-wavelength information is combined to trigger coordinated telescopes for rapid-response (minutes later) and later-time deep spectroscopy and imaging. DWF is on field before, during, and after fast transients burst, making it the best program to detect and understand the counterparts to FRBs, including coherent bursts, and resolve their nature for the first time. DWF has been a trailblazer for LSST and future large transient survey programs and is an excellent platform to develop machine and deep learning techniques, Big Data
transfer and processing solutions, and real-time data analyses.

8

The Galactic ISM in the GASKAP Era: Mapping Atomic and Diffuse Molecular Gas with HI and OH

I will discuss progress in mapping the atomic and diffuse molecular components of the ISM in the Milky Way, with particular focus on observing and correcting for the so-called "dark ISM". It is now known that a significant fraction of the Milky Way ISM resides in this "dark" phase, usually defined as a mixture of cold, optically thick HI and diffuse molecular hydrogen with densities that are insufficient to form and shield CO. Surveys such as GASKAP will give an unprecedented view of the Milky Way's gas, not only via improved HI emission maps, but also through HI and OH absorption, which can be used to recover and characterise material that would otherwise remain unseen. I will also provide a general update on the status of the GASKAP project.

14

The Milky Way - evidence for Seyfert activity in the recent past

The Galaxy's supermassive black hole is a hundred times closer than any other massive singularity. It is surrounded by a highly unstable gas disk so why is the black hole so peaceful at the present time? This mystery has led to a flurry of models in order to explain why Sgr A*is radiating far below (1 part in 10^8) the Eddington accretion limit. But has this always been so? Evidence is gathering that Sgr A* has been far more active in the recent past, on timescales of thousands of years and longer. The bipolar wind discovered by MSX, the X-ray/gamma-ray bubbles discovered by ROSAT/Fermi-LAT, the WMAP haze, the positronium flash confirmed by INTEGRAL, and new UV spectroscopy from HST are suggestive of something truly spectacular in the recent past. We present new evidence that the Galactic Centre was a full blown "active galaxy" just a few million years ago. The echo of this incredible event can be seen today imprinted across the Galaxy. This leads us to a developing paradigm for Sgr A* activity over billions of years.

4

The interstellar medium towards the unidentified gamma-ray source HESS J1804-216

Kirsty Feijen[1]

[1] *The University of Adelaide*

Corresponding Author(s): a1669469@adelaide.edu.au

I will present an overview of the interstellar medium surrounding the mysterious HESS source; HESS J1804-216, including data from the Mopra CO survey and the Southern Galactic Plane Survey of HI. This will include a focus on understanding the origin of cosmic rays from HESS J1804-216.

20

The roles of gravity, turbulence and magnetic fields in the ISM.

In this presentation I describe how automated data processing techniques can be used to interpret the many wide-field, high-resolution, large multi-molecular-line datasets that now exist.

I will also discuss how these techniques have been used to analyse the CSIRO CASS Mopra telescope millimetre-wave large surveys of the G333 and Vela C molecular clouds.

I will show how the Mopra surveys have allowed us to determine which molecules respectively trace the turbulent and gravitationally bound components of the interstellar medium, and show how comparing subsets of molecules, for example CS, N2H+, HCO+ and C2H, can be used to highlight star forming regions at different stages of development in these large datasets.

13

Through a glass darkly: what do we really know about fast radio bursts?

Fast radio bursts (FRBs) are powerful extragalactic bursts of
radio waves with millisecond duration. Their origin is a mystery, with dozens of theories, from supramassive magnetars to lensing by astrophysical plasmas, being proposed to explain their extreme energies. Even basic questions surrounding FRBs, such as "do they all repeat?",
"do they originate in the near or distant universe?", and "what is their intrinsic luminosity function?" remain unanswered.

Attempts to resolve these questions have been hampered by the plethora of experiments used to study them. The effects of various detection parameters - telescope beamshape, search algorithms etc - interact with a poorly understood luminosity function to obscure intrinsic FRB properties. In this talk, I present the latest analysis of FRB data from The Commensal Real-time ASKAP Fast Transients Survey (CRAFT), and what progress we have made towards answering these questions.

17

Towards a Cherenkov Telescope Ring - Overview and Status

Simon Lee[1] ; Sabrina Einecke[2]

[1] *University of Adelaide*

[2] *The University of Adelaide, Australia*

Corresponding Author(s): sabrina.einecke@adelaide.edu.au, simon.lee@adelaide.edu.au

The Cherenkov Telescope Ring is an idea for a network of Imaging Air Cherenkov Telescopes around the globe. This would allow for 24-hour coverage of the very-high-energy gamma-ray sky for follow-up and long-term observations. This presentation will introduce the project and give an overview of the scientific motivations, relevant linkages, and current efforts being put forth in Australia.

3

WIMPs are surely dead. Or are they?

Csaba Balazs[1]

[1] *U Monash*

Corresponding Author(s): csaba.balazs@monash.edu

There's a lot of confusion about the plausibility of the existence of Weekly Interacting Massive Particles in the broader particle astrophysics community. In this talk I review the most popular WIMP

candidates and the most rigorous experimental limits in them. I argue that the simplest WIMP candidates are not only alive but also in the potential reach of CTA.

22

Welcome

Corresponding Author(s): gavin.rowell@adelaide.edu.au