POSSUM Newsletter 4

August 2013

From the PIs

It has been a while since the last POSSUM newsletter, but there has been a lot of activity during that period. The two main focuses of the year so far have been the annual POSSUM meeting, held in Penticton in May 2013, and the development of an ASKAP early science case.

Our annual meeting was held jointly with the EMU and GALFACTS projects over 20-24 May 2013, and was attended by over 30 people from Australia, Canada, the USA, Italy and the UK. We had extensive discussions on the plans for POSSUM commissioning and calibration, on the formats for POSSUM data products, on our ongoing Faraday rotation measure data challenge, and on ASKAP early science. The workshop program and links to some of the presentations are at http://askap.pbworks.com/w/page/62931960/2013May20.

In May 2013, CSIRO announced its intention to develop an early science program for ASKAP, commencing with 12 PAF-equipped dishes in early 2015, and continuing through until the complete ASKAP array is deemed ready to begin normal operations. On 5 August 2013, a one-day workshop was held at CSIRO to hear from the ASKAP survey science teams about their early science plans, and to look for options for a unified early science program. The POSSUM team made several presentations at this workshop, the main focus of which was a broadband (700-1800 MHz) wide-field survey that would provide a spectacular view of depolarisation and non-lambda-squared Faraday rotation to a large sample of AGN and radio galaxies. Our proposed survey and scientific justification can be found at http://askap.org/possum/Documents. CSIRO will soon be generating a report from this workshop, for which further feedback will be sought. Within the next couple of months, the CASS Chief will then finalise and approve an ASKAP early science program, in which we hope and expect polarisation will play an important role.

Meanwhile, we now have a fantastic new POSSUM logo, designed for us by Brooke Steel. You can download the logo in many different formats and styles from http://askap.org/possum/Logos - please use it when promoting POSSUM in your talks, posters and other presentations.

In this newsletter, you can read updates on RM data challenge and POSSUM pipeline, summaries of new papers on a broadband circular polarisation measurement and magnetic fields around galaxies at redshift of about 1, and a profile of POSSUM researcher Jo-Anne Brown.

Bryan Gaensler, Tom Landecker and Russ Taylor

POSSUM Activities

Updates on RM data challenge

Xiaohui Sun

There is a growing appreciation that RM synthesis is only one of many methods that can potentially be used to characterise different aspects of Faraday rotation and RMs. We have thus been considering the broader suite of issues around optimal approaches to "RM determination".

The idea of data challenge was initiated in May 2012 and the goal is to find proper methods for POSSUM to reconstruct complex Faraday structures (POSSUM Newsletters 2 and 3). The first round of the data challenge is now complete. The input scenarios used for this first round were: one Faraday thin component, two Faraday thin components with separations either larger or smaller than the width of the RM spread function, one Faraday thick component and mixtures of Faraday thin and thick components. The frequency range used was 1.1-1.4 GHz and the assumed signal-to-noise ratio was 31.6.

We received results based on RM synthesis and RM clean, wavelet, compressive sampling and QU-fitting. Larry Rudnick has represented all the results in a colour scheme explained in the table below.

colour	χ^2/d.o.f.	weighted RM difference	number of components
	<1.05	<5	match
	1.05−1.10	5−10	roughly match if thick
	>1.10	>10	don't match

The results are shown in Figure 1. Two initial conclusions can be made: (1) QU-fitting yields good results for nearly all input models; (2) RM synthesis and RM clean give reasonable estimates of the weighted RM in the case of two components, implying that they should suffice for science using a foreground RM grid. We are now writing up the results.

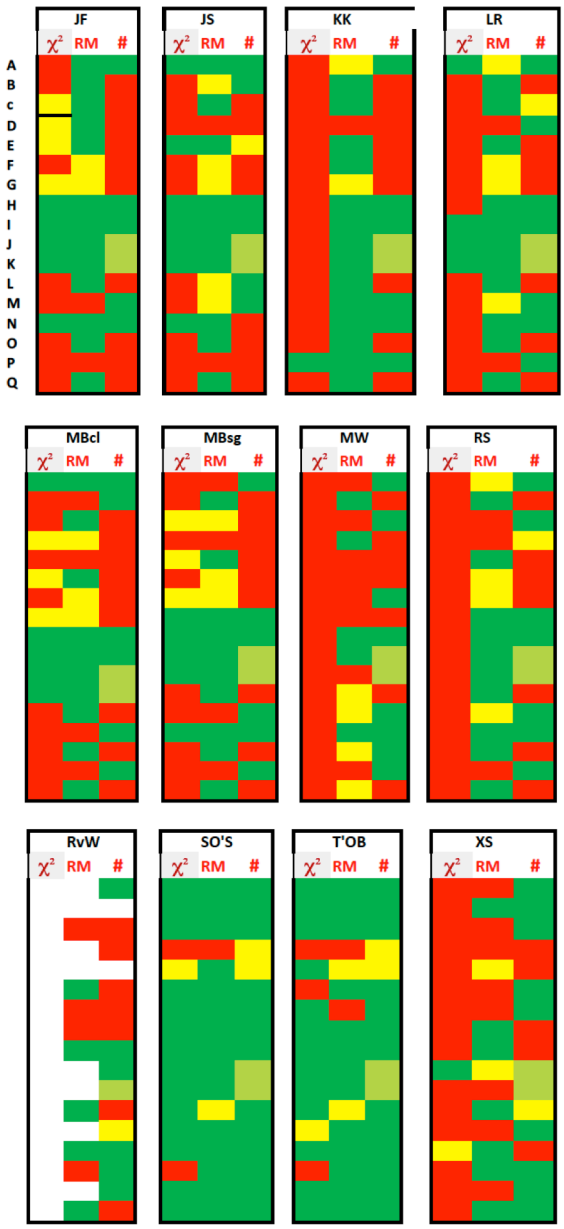

Figure 1: Results from RM determination data challenge one. The methods include: (1) RM synthesis and RM clean; (2) wavelets; (3) compressive sampling; (4) QU fitting. The input models cover: (1) one Faraday thin component in H, I and N; (2) two Faraday thin components in A, B, C, F, G, L, M, O, P and Q; (3) one Faraday thick component in D, G, K; (4) one Faraday thin component plus one Faraday thick component in E, J.

Many thanks for all the participants who applied their methods to the test data and returned their results.

Many people have shown an interest in participating in a second round of the data challenge that was discussed during the Penticton meeting in May this year. We will start the challenge once the frequency configuration for ASKAP early science observations has been decided.

Updates on POSSUM pipeline

Cormac Purcell

I have finished a POSSUM pipeline written in python with built-in web-server and SQL database. The pipeline is able to: (1) demonstrate an end-to-end pipeline for ASKAPSoft implementation; (2) provide a framework to test new pipeline modules; (3) provide a tool to create RM catalogues for general datasets; (4) provide a simple method to visualise polarisation properties.

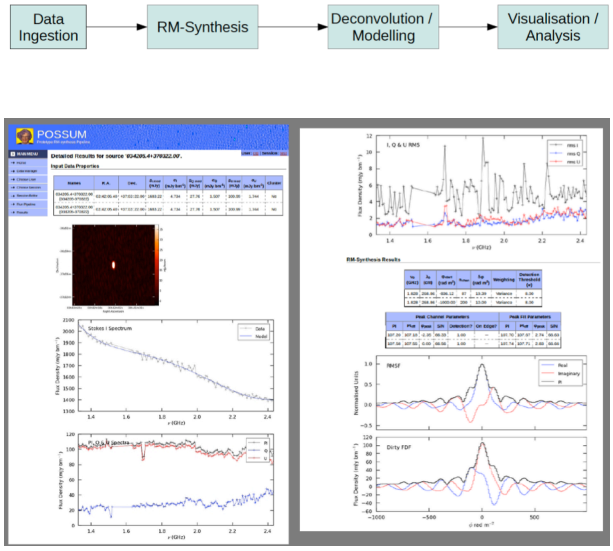

Figure 2: POSSSUM Pipeline flow-chart and visualisation of polarisation parameters.

A flow-chart for the pipeline and an example of output plots are shown in Figure 2. After some cleaning up and more bug-testing, the code will be ready for release. I am currently trying to integrate some QU-fitting code into the pipeline and split off a stand-alone version.

A Broadband radio circular polarisation spectrum of the relativistic jet in PKS B2126-158

Shane O'Sullivan, Naomi McClure-Griffiths, Ilana Feain, Bryan Gaensler, Robert Sault

We present full-Stokes polarisation observations of the quasar PKS B2126-158 (z = 3.268) from 1 to 10 GHz using the Australia Telescope Compact Array. The source shows large fractional circular polarization detected at high significance across the entire band (Figure 3). This allows us to construct the most robust circular polarization spectrum of an AGN jet to date.

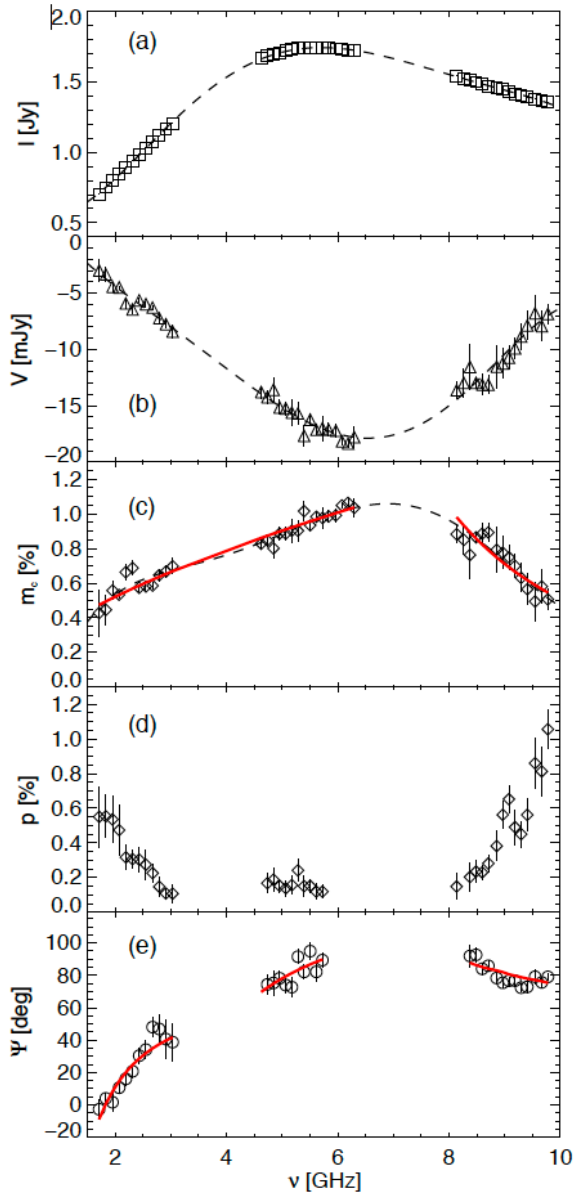

Figure 3: Integrated spectrum of PKS B2126-158 from 1.5 to 10 GHz with data points plotted in 128 MHz intervals: (a) Stokes I in Jy (b) Stokes V in mJy (c) degree of circular polarisation (d) degree of linear polarisation (e) linear polarisation angles in degrees.

We find that the fractional linear polarisation is strongly anti-correlated with the fractional circular polarisation, which is the first clear relation between these two polarisations of an AGN jet. This reveals the action of Faraday conversion of linear polarisation to circular polarisation within the jet. The key to understanding the true driving force behind the conversion is to determine whether the observed Faraday rotation is internal or entirely external to the jet. The simplest interpretation of our observations favours some internal Faraday rotation, implying that Faraday rotation-driven conversion of linear polarisation to circular polarisation is the dominant circular polarisatioin generation mechanism.

O'Sullivan et al. 2013, MNRAS in press (arXiv: 1307.5121)

Profile – Jo-Anne Brown

Jo-Anne obtained her PhD in astrophysics from the University of Calgary in 2002. She was then awarded Alberta Ingenuity Fund Associateship to work as a postdoc before she took up the faculty position at the same university. Her path to where she is today has been far from linear. Here a shorten version of the profile is presented and a full version can be found at – http://askap.org/possum/Documents/Newsletters

What are your main research interests?

My research is focused on Galactic magnetism. I have been working mainly on understanding the geometry of the large-scale Galactic magnetic field in the disk.

What excites you about POSSUM?

The really exciting thing is the density of coverage, and the incredible range of questions related to Galactic magnetism that will be addressed by POSSUM.

What are the main challenges for POSSUM?

It will be difficult, for example, to separate and clearly identify contributions to the RM 2D structure that result from smaller scale structures and from looking across larger scale features.

What papers are you working on?

I have 2 projects I am trying to complete this year. The first is C.L. Van Eck's MSc thesis paper. The second paper is the final CGPS catalogue paper.

What do you enjoy outside work?

I have an "almost" 9 years old son, Sean, with whom I really love spending time. I also really love dance, and I love watching "Dancing with the Stars". I keep hoping they will introduce a new show called "Dancing With the Nerds" so that I can try to become a contestant!

Other Related Science Results

The extent of magnetic fields around galaxies out to z~1

M. L. Bernet, F. Miniati, S. J. Lilly

Quasars with strong intervening Mg II absorption lines in their optical spectra display statistically enhanced Faraday RMs than those without, indicating the presence of large-scale magnetic field in the intervening galaxies.

We use multi-color optical imaging to identify the galaxies likely hosting the magneto-active plasma, and to constrain the location of the latter with respect to the putative parent halo. We find that all of the sightlines with high |RM| pass within 50 kpc of a galaxy and that the |RM| distribution for low impact parameters is significantly different than for larger impact parameters (Figure 4). In addition, we find a decrease in the ratio of the polarization at 21 cm and 1.5 cm toward lower impact parameters.

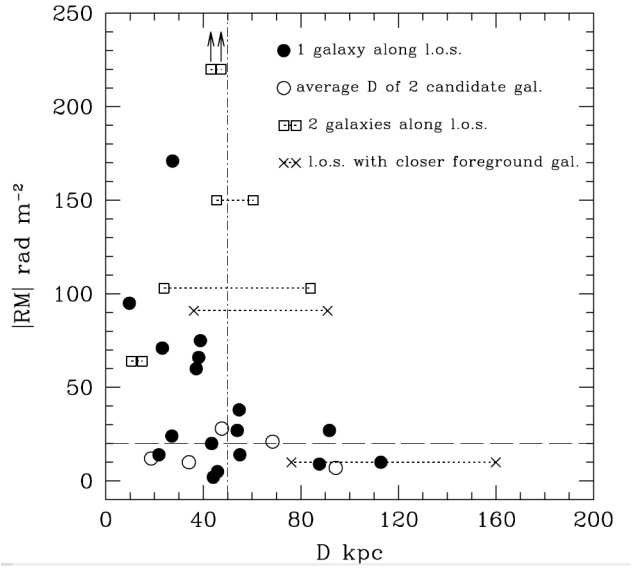

Figure 4: Observed |RM| vs. impact parameters of quasars with intervening Mg II absorptions.

These two effects strengthen the association of excess |RM| with intervening galaxies, and suggest that intervening galaxies operate as inhomogeneous Faraday screens. These results cannot be explained with only a disk model for the magnetic field, but are consistent with highly magnetized winds associated with Mg II systems. We infer strong magnetic fields of a few tens of μG. These galactic winds can significantly alleviate the small-scale helicity bottleneck of α–Ω galactic dynamos.

Bernet et al. 2013, ApJL, 772, L28

A relation between the warm neutral and ionised media observed in the Canadian Galactic plane survey

T. Foster, R. Kothes, J. C. Brown

We compare RMs and the optically thin atomic hydrogen column density measured toward unresolved extragalactic sources derived from the Canadian Galactic Plane Survey (CGPS). We find a strong relationship between the number of hydrogen atoms in a 1 cm^2 column through the plane and the mean RM along the same line of sight and path length. The relationship is linear over one order of magnitude of column densities (Figure 5), with a constant RM to HI column density ratio of −23.2±2.3 rad m^{-2}/10^{21} atoms cm^{-2}. From this slope we calculate a mean volume-averaged magnetic field in the second quadrant of 1±0.1 μG, assuming an ionization fraction of 8%. The remarkable consistency between this field and the field of 1.2μG found with the same RM sources and a Galactic model of dispersion measures suggests that the partially ionized warm neutral medium is the dominant form of the magneto-ionic interstellar medium.

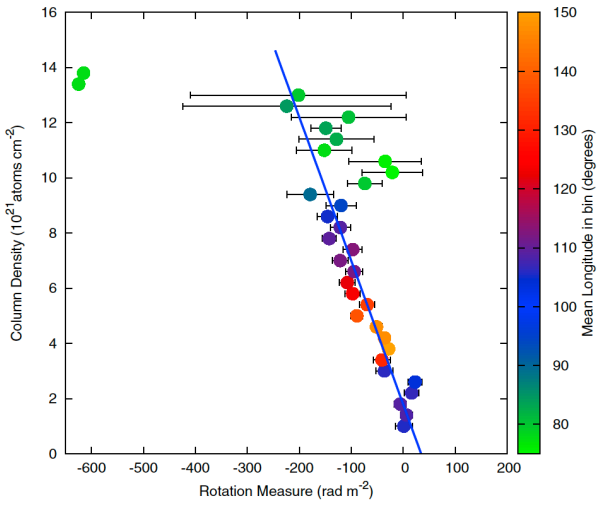

Figure 5: Atomic hydrogen column density vs. RM for 1970 sources in the CGPS.

Foster et al. 2013, ApJL, 773, L11