

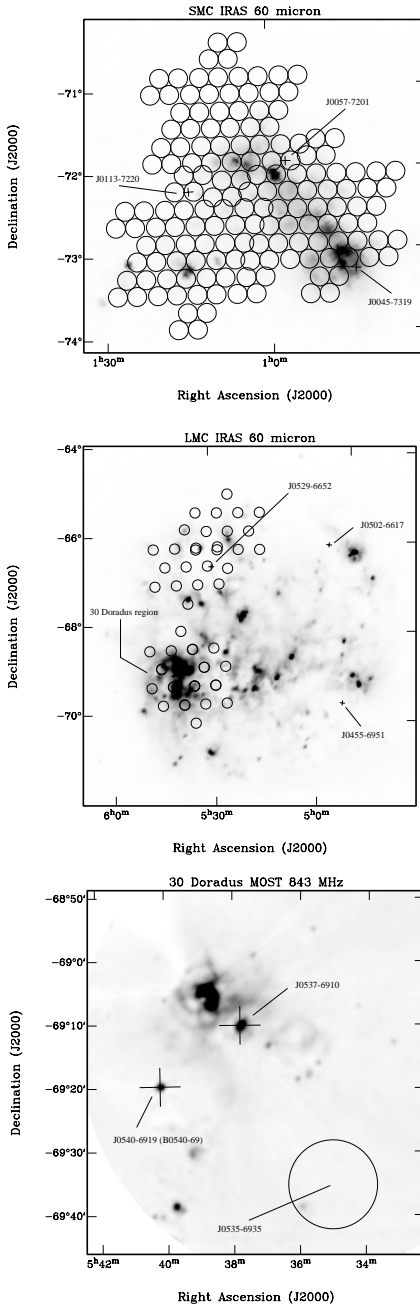
# New Radio Pulsars in the Magellanic Clouds

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## Scientific Motivation for Magellanic Cloud Pulsar Searches and Studies

- High fraction (50%) of known pulsar systems in MCs are interesting/unusual, want to find more:
  - *PSR J0045–7319* in SMC: Binary system, 9  $M_{\odot}$  B star companion
  - *PSR J0540–6919* (B0540–69) in LMC: Crab twin, X-ray and radio emitter, associated plerion, fourth youngest known
  - *PSR J0537–6910* in LMC: X-ray emitter, no radio emission, fastest rotation-powered pulsar not spun up, associated plerion
- Study high end of pulsar luminosity function (large distances to MCs ( $d_{SMC} \sim 60$  kpc,  $d_{LMC} \sim 50$  kpc))
- Test predictions of number of pulsars expected in MCs (pulsar birth rates from SNRs, mass estimates of MCs, star formation rates in MCs)
- Dispersion measures (DM) of MC pulsars (characterize plasma distribution within MCs and between Milky Way and MCs)

## SURVEY COVERAGE



- Measure proper motions (well known distance to MCs  $\rightarrow$  estimate pulsar velocities, trace origins to OB associations?)

## SMC Pilot Survey and LMC Observations

- Parkes 20 cm multibeam receiver (same as PM Survey), efficient coverage (13 beams per pointing)
- Twice as sensitive as most sensitive phase of previous 50 cm survey [McCulloch et al. 1983, McConnell et al. 1991], much greater sensitivity to pulsars with  $P < 100$  ms
- Region bounded by SMC IRAS 60  $\mu$ m emission surveyed for pilot study
- SMC pilot survey characteristics:
  - 12 pointings of multibeam receiver (156 beams)
  - Center frequency 1374 MHz, bandwidth 288 MHz (96 channels  $\times$  3 MHz per channel  $\times$  2 polarizations)
  - Integrations of 8400 sec per pointing at 0.25 ms sampling
  - Nominal sensitivity to long-period pulsars  $\sim 0.08$  mJy ( $L_{100} \sim 2000$  mJy kpc $^2$  for  $d_{SMC} = 60$  kpc and  $\alpha = -1.6$ )

- Data dispersed at trial DMs, ranging from 0 to 442 pc cm $^{-3}$
- Data Fourier transformed on Sun workstations using FVLSAI spectral analysis package (FFT length  $N = 2^{25}$  pts)
- Original data then re-dispersed and folded at candidate periods
- Several LMC pointings also observed, part of targeted deep searches (integration time 16800 sec per pointing)

## Discoveries from Pilot Survey and Timing Results

- Three new pulsars found:
  - *PSR J0113–7220*: in SMC (DM = 125 pc cm $^{-3}$ ), very luminous, fast ( $P = 326$  ms), characteristic age  $\tau_c = 1$  Myr
  - *PSR J0057–7201*: foreground pulsar (DM = 27 pc cm $^{-3}$ ), scintillates, old ( $\tau_c = 117$  Myr)
  - *PSR J0535–6935*: in LMC (DM = 90 pc cm $^{-3}$ ), faint, fast ( $P = 200$  ms), no phase-connected timing solution possible
- Timing results for three known LMC pulsars (J0455–6951, J0502–6617, J0529–6652) also presented
- Brings total number of known pulsars in MCs to 8 (2 in SMC, 6 in LMC)

## Future Prospects: A Complete Multibeam Survey of the Magellanic Clouds for Pulsars

- Survey area surrounding SMC (for pulsars which drift out),  $4^{\circ} \times 4^{\circ}$  total area  $\rightarrow \sim 30$  multibeam pointings
- Survey rest of LMC and surrounding area,  $8^{\circ} \times 8^{\circ}$  total area  $\rightarrow \sim 120$  multibeam pointings
- Complete survey:  $\sim 15$  days of telescope time
- Data processing: reduce sampling rate to 1 ms, use PM Survey analysis software, complete processing in  $\sim 2$  months
- How many pulsars should we find?
  - Estimated number of potentially observable pulsars with  $L_{100} > 1$  mJy kpc $^2$  in MCs (McConnell et al. 1991, Vangioni-Flam et al. 1980, Lyne et al. 1998):  
 $N_{SMC} \sim 1200 \pm 400$   
 $N_{LMC} \sim 8000 \pm 2300$
  - Estimated number with  $L_{100}$  above survey detection limits:  
 $N_{SMC}(L_{100} > 2000 \text{ mJy kpc}^2) \sim 0.6 \pm 0.2$   
 $N_{LMC}(L_{100} > 1350 \text{ mJy kpc}^2) \sim 6 \pm 2$
  - Number of pulsars in MCs found to date: consistent with predicted estimates

## SURVEY SENSITIVITY

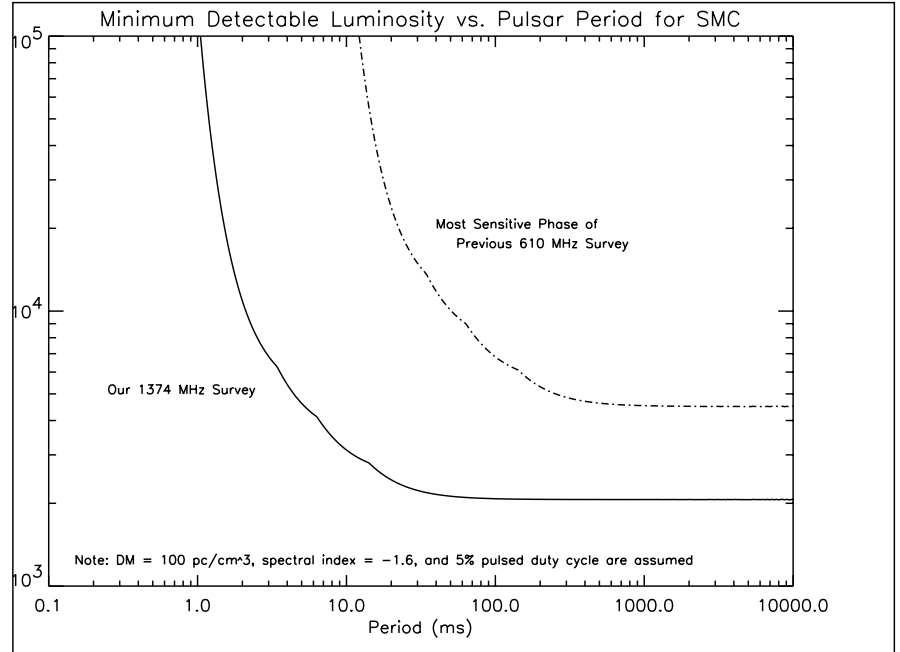


Table 1. Currently Known Magellanic Cloud Pulsars

Name	Location	Radio?	X-ray?	Unusual/Interesting Features
J0045–7319	SMC	yes	no	Binary with B star companion
J0013–7220	SMC	yes	no	
J0535–6935	LMC (30 Dor)	yes	no	
J0537–6910	LMC (30 Dor)	no	yes	Fastest known non-recycled, plerion
J0540–6919	LMC (30 Dor)	yes	yes	Crab twin, plerion
J0455–6951	LMC	yes	no	
J0502–6617	LMC	yes	no	
J0529–6652	LMC	yes	no	