Single Pulses From Nearby Galaxies

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in collaboration with

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Motivation:

Searches for any manifestation of neutron stars at radio wavelenghts (pulsars) in nearby galaxies could help us to to probe:

i) the stellar content of these systems.

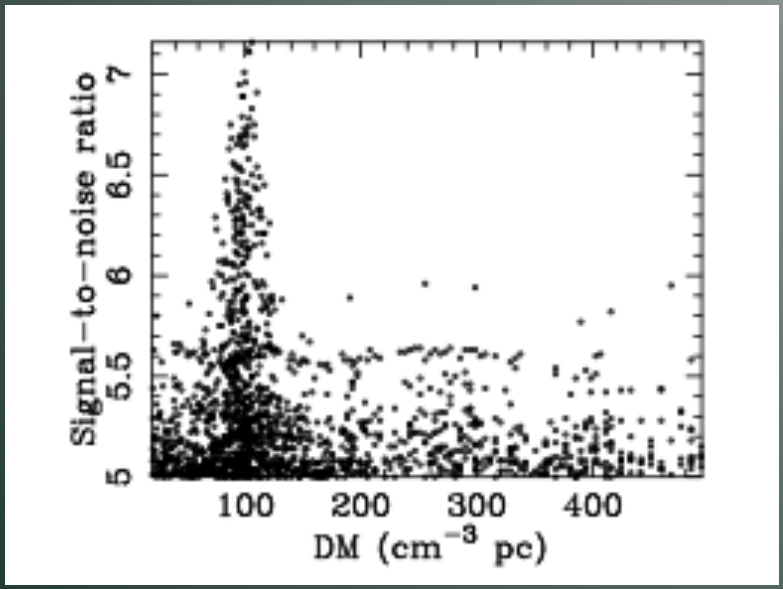
ii) the nearby intergalactic medium.

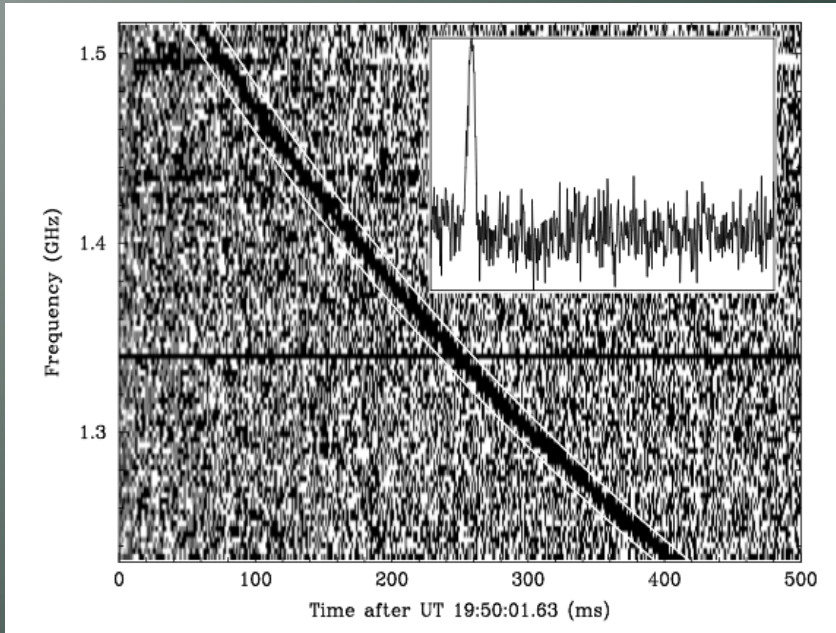
iii) some intrinsic dynamic properties of the dwarf spheroidal systems.

iv) detection of rare astrophysical transient phenomena

Distant single pulses – I

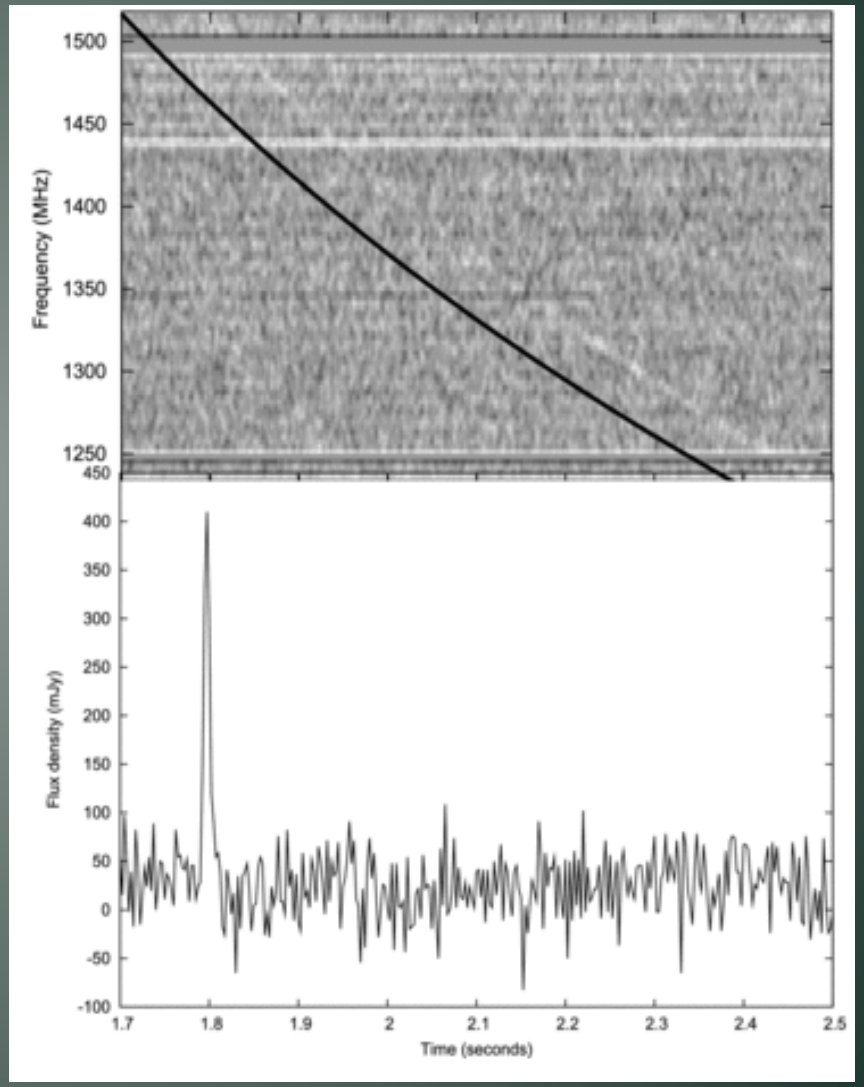
We can potentially learn about the near intergalactic content of free electrons by detecting distant pulsars at different galactic latitudes such as B0529-66, B0540-69 both detected in the LMC, and the Lorimer pulse detected in the Southern Hemisphere at cosmological distances (Lorimer *et al*. 2007).





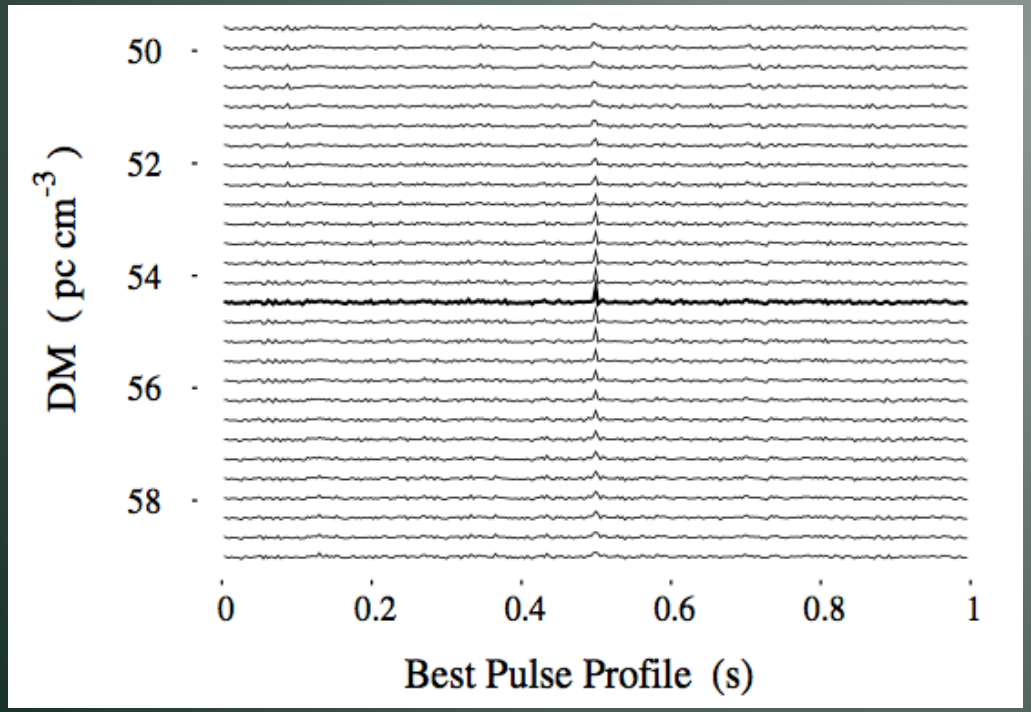
Distant single pulses – II

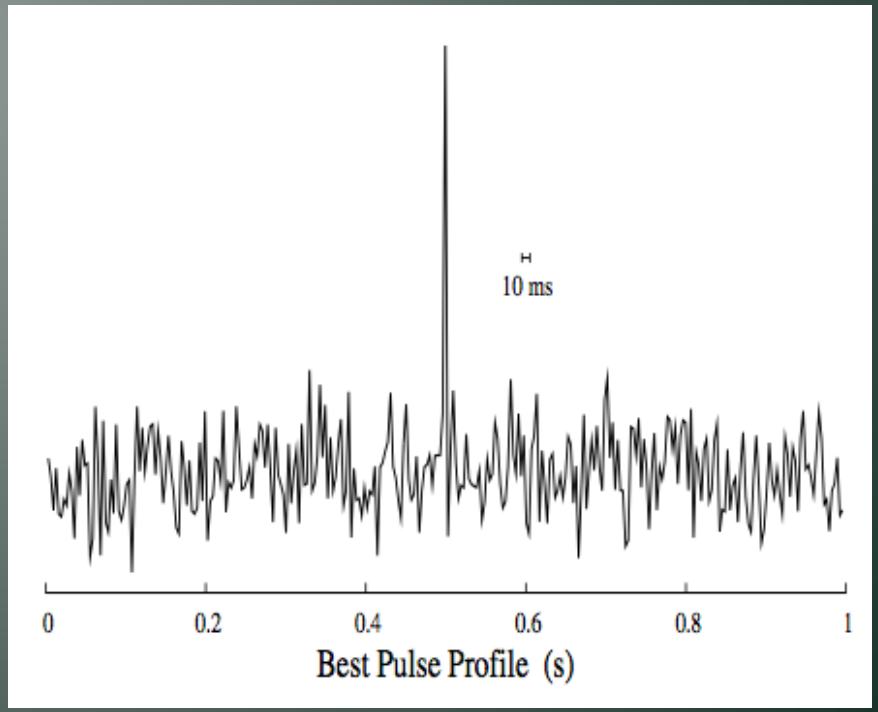
J1852-08 is yet another remarkable highly dispersed individual pulse. With a DM of 745 pc cm^{-3} and a flat spectrum, this single pulse suggests a magnetar origin however, this fact does not rule out a more violent origin related to the anhiliation of a BH (Keane et al. 2012)



Distant pulses – II

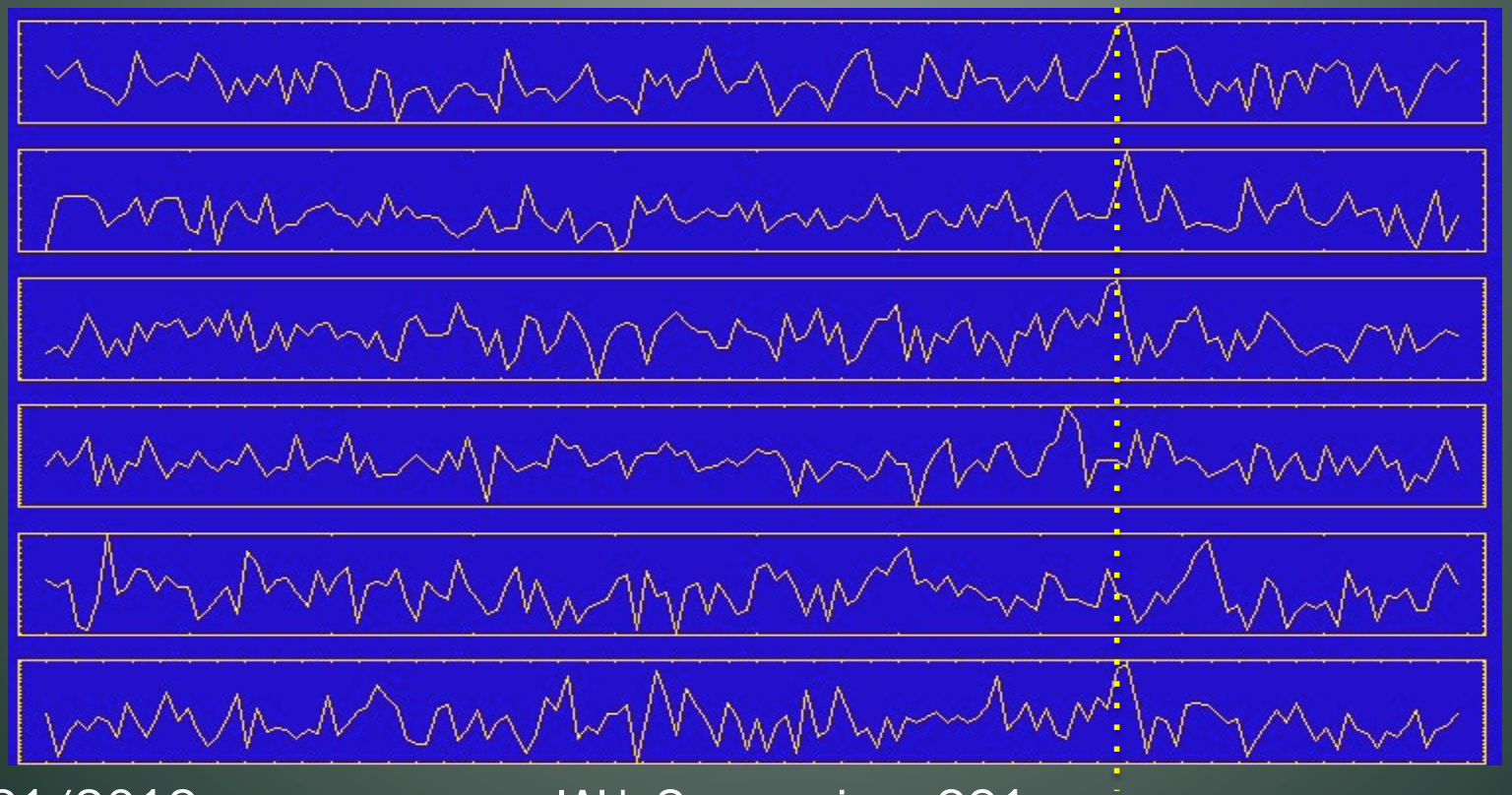
More recently, higly dispersed pulses were found by the survey of pulsars and fast radio in M31 made with the WSRT 8gr8 mode (Rubio-Herrera et al. submitted). Particularly interesting were 6 pulses detected in about 3600 s of observation at DM = 54.7 pc cm^{-3} .





Pulses in M31

These pulses were weak, S/N<6, and may be periodic, implying a rotating neutron star. Our periodicity analysis has shown a period > 5ms being the two most probable of P_1= 0.235 s and P_2= 0.295 s.



Searches for pulsars in the dwarf spheroidal satellites of the Milky Way

Why the dwarf spheroidals?

At a glance they *may not be* the best places to look for pulsars because they exhibit:

- Very low star forming rates implying that perhaps too few NS are born inside these galaxies to be detectable.

- Low metallicities hence most of massive stars may collapse directly into a black hole (Heger et al. 2003).

However ...

Macarone et al. (2005) have shown that there are LMXB's in the Sculptor Dwarf Spheroidal Galaxy.

These stars occur in old stellar populations and have space velocities of 20-100 km s^{-1} (Podsialowski *et al.* 1995).

These velocities exceed the stellar velocity dispersion of the Sculptor dSph of ~11 km s^{-1}.

How the Sculptor dSph (and probably other dSph) retains these systems?

Dark Matter?

- All these ideas have difficulties explaining how these galaxies retain their LMXBs.

A good explanation appears to be a stronger gravity in the galaxy due to the presence of a halo of Dark Matter.

- Recent observations evidence the existence of dark matter haloes around some of the dSph satellites of the Milky Way (Kleyna *et al.* 2001).

- Lack of tidal distortion in the Sculptor dSph has been interpreted as indirect evidence of a dark matter halo. (Coleman *et al.* 2005).

Pulsars as probes of Dark Matter in dSph –I?

An extended halo of dark matter would then imply a halo of LMXBs, something we can observationally test! (Dehnen & King 2005).

MSPs are direct descendants of LMXBs. Therefore searching for these pulsars would allow an *in situ* quantitative modelling of the dark mater haloes by detecting the spatial location of the MSPs in these galaxies.

Pulsars as probes of Dark Matter in dSph - II?

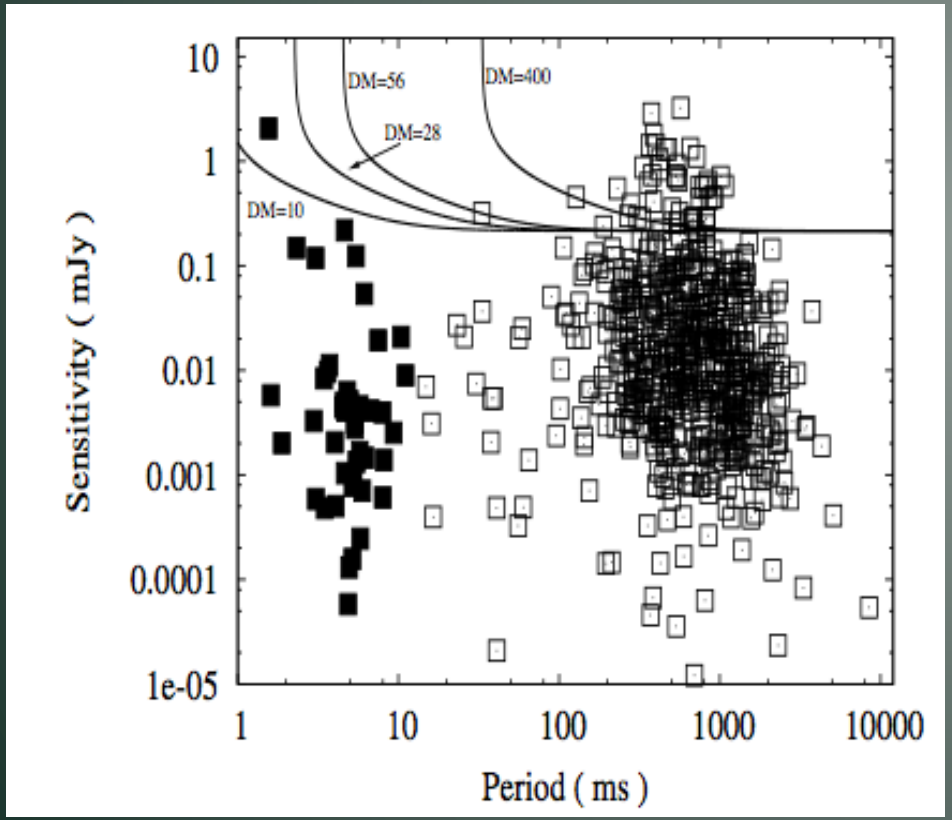
The enormous distances at which dSph are located, the very low numbers of MSPs within them, and other factors (beaming, luminosity, etc.) may hemper these searches.

However to increase the chance of detecting them with the current facilities, one could observe many (if not all) the dSph satellites of the Milky Way.

We have initiated a campaign to observe some of these galaxies (Rubio-Herrera *et al*. in prep).

Our survey at a glance

Observations made with the Green Bank Radio telescope using GUPPI at 350 MHz.



-Sculptor dSph .....10 h* 90 kpc

-Ursa Minor dSph …5 h 60 kpc

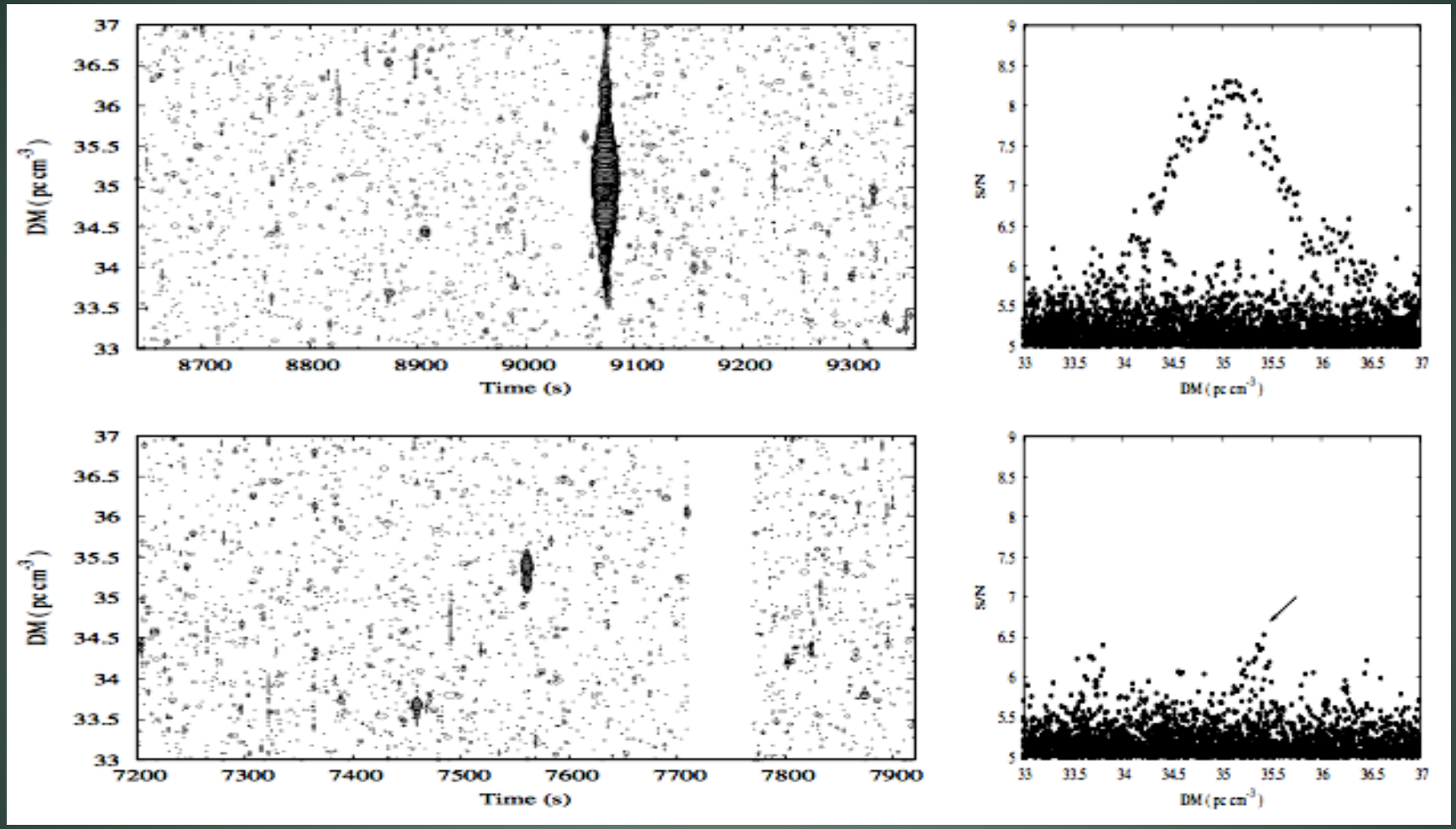
-Draco dSph …..... > 4 h 80 kpc

-Leo I dSph .....13 h 250 kpc

*(+10 h this fall with GBT)

Most of the data has been reduced in the ATOCATL cluster located in the Instituto de Astronomia in Mexico City.

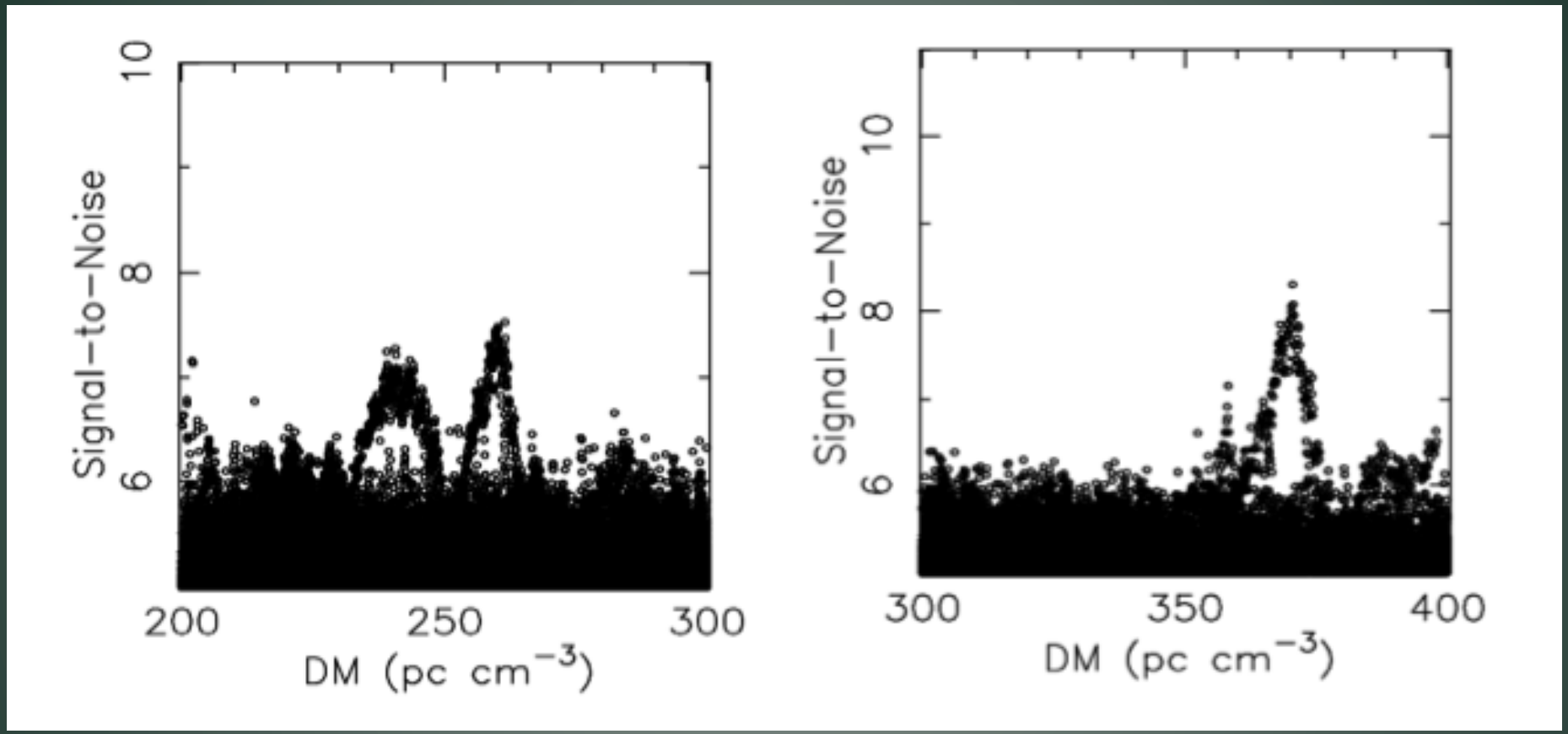
Some preliminary results...



Unconfirmed single dispersed pulses from Sculptor.

(Rubio-Herrera *et al*. in prep).

Some preliminary results - II



Unconfirmed high dispersed single pulses from Ursa Minor Dwarf.

(Rubio-Herrera *et al*. in prep).

Conclusions

Searches for pulsars in dwarf spheroidal galaxies offer us the possibility for probing:

-The interestellar/galactic medium.

-The stellar content of these galaxies and (distant MSPs and/or normal PSRs).

-If any PSR is detected and its velocity measured, we can test the existence of dark matter haloes.

-The possibility of detecting new astrophysical transient sources.

-Our searches have revealed so far a few single pulses and none MSPs or normal pulsars.

Future Work

- We are developing synthetic models to describe de pulsar population of dSph galaxies and to establish calculate the probablity of succesful detections of MSPs.
- The outstanding sensitivity of LOFAR and SKA, may confirm the existence of MSPs and their distribution/dynamics within the dSph.
- Finally, if these distribution appears as a halo of around the dSph, we could investigate the dynamics of dark matter in the dSph satellites of the Milky Way.

Work in progress, stay tuned.

Thank you for your attention!