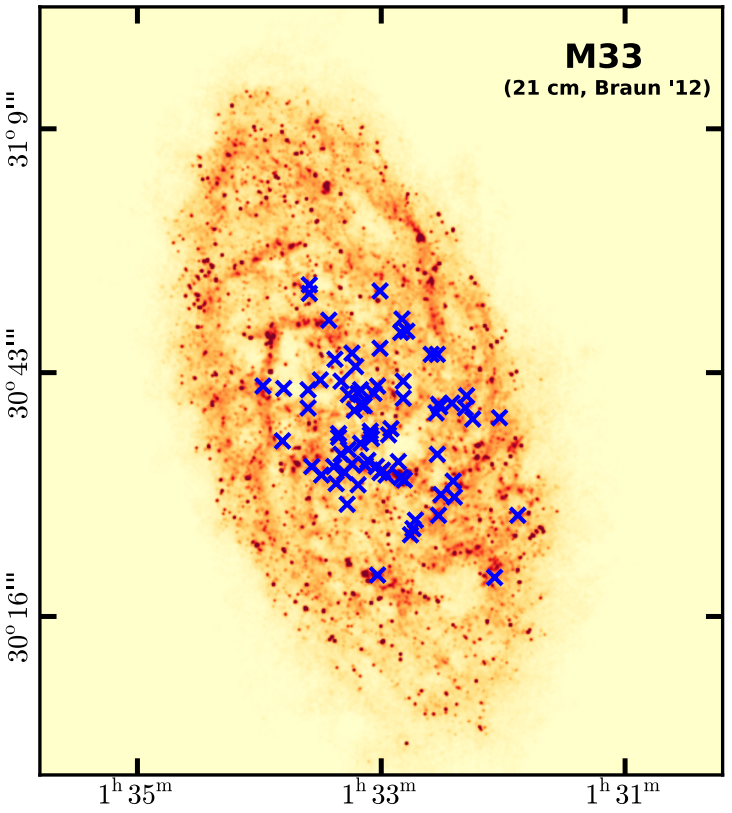
A statistical model of Local Group SNRs

[arXiv: 1605.04923]



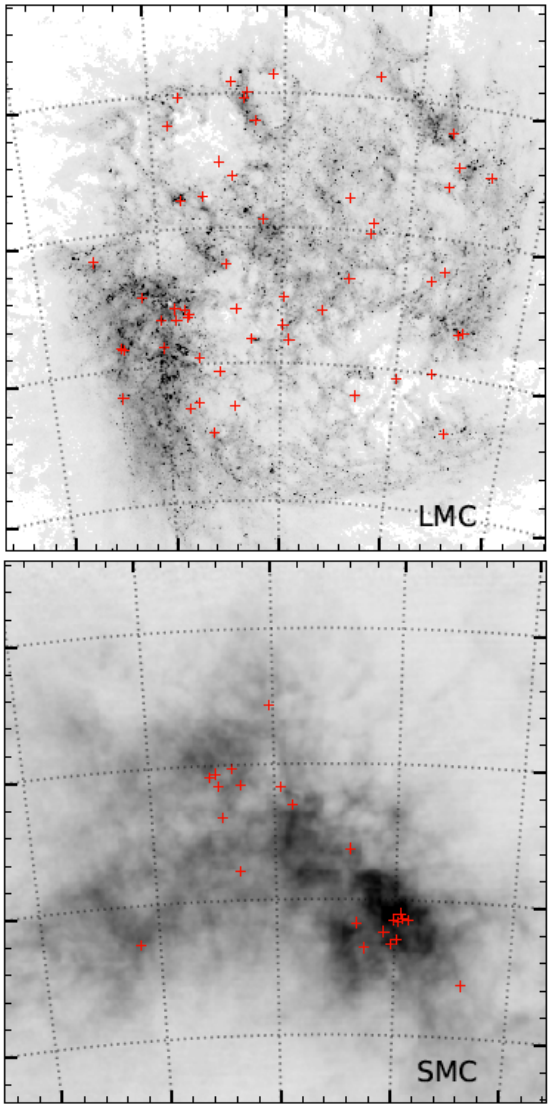
Sumit K. Sarbadhicary

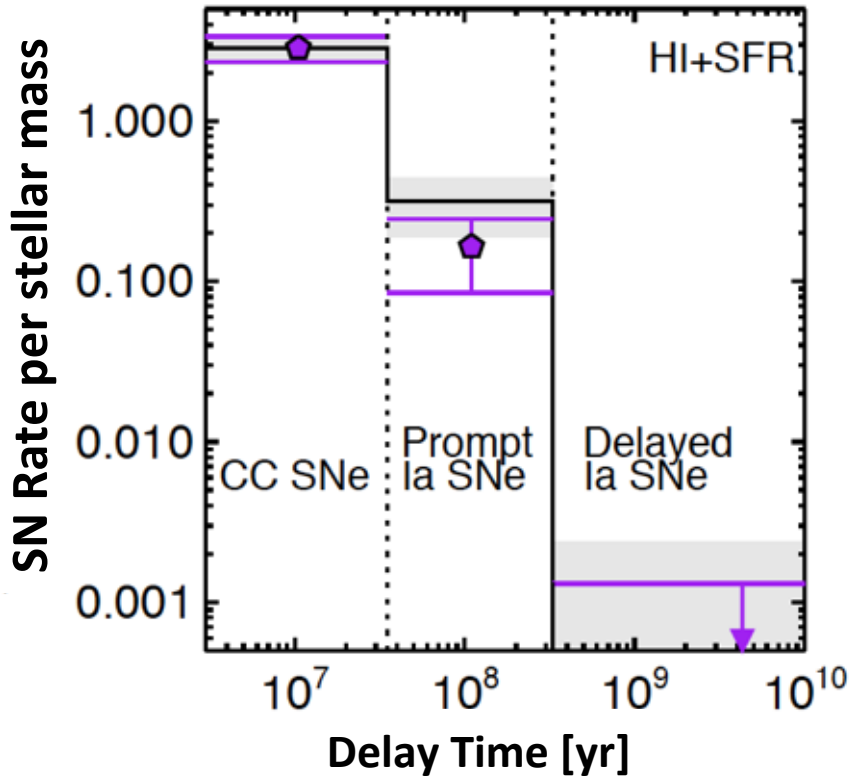
PITT-PACC, University of Pittsburgh, USA

Carlos Badenes **Laura Chomiuk**

Damiano Caprioli **Daniel Huizenga**

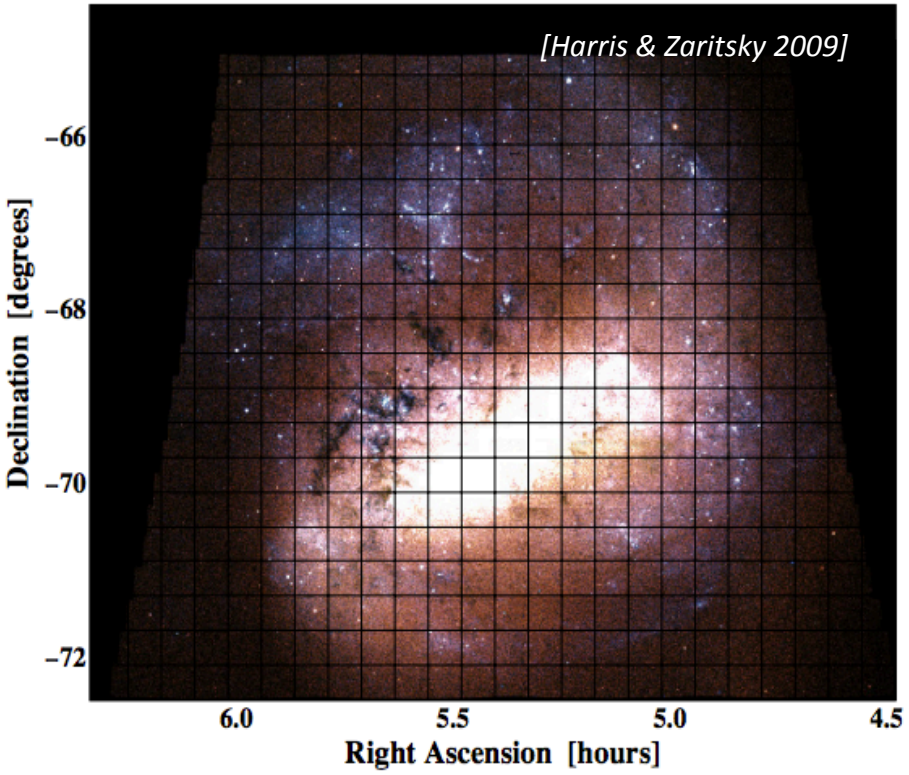
SN delay-time distribution from SNR surveys

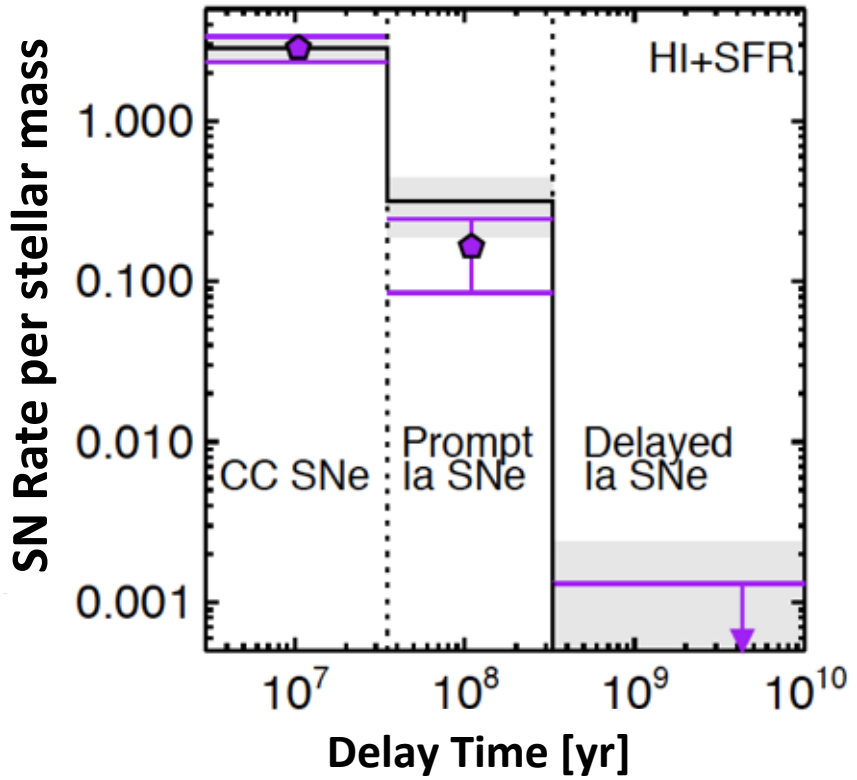




Badenes, Maoz & Draine (2010), Maoz & Badenes (2010)

SN delay-time distribution from SNR surveys





Resolved Stellar Populations

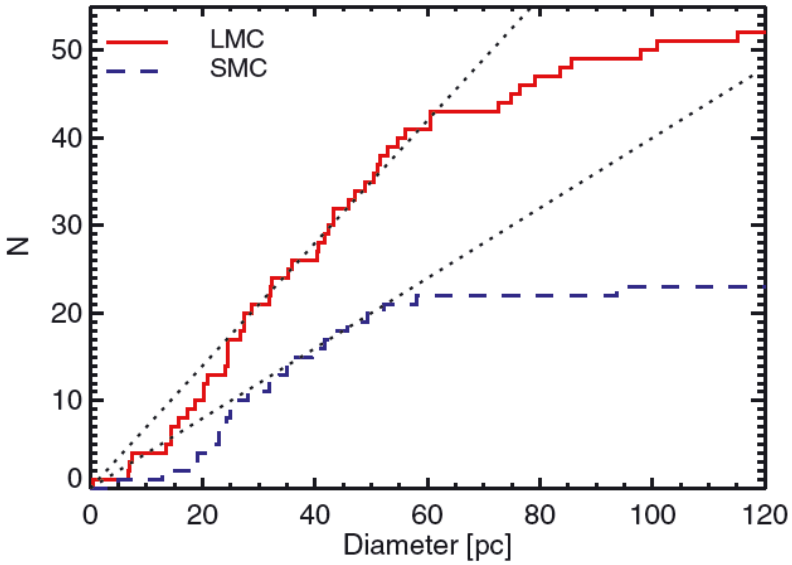
Badenes, Maoz & Draine (2010), Maoz & Badenes (2010)

Need visibility times of SNR surveys to measure SN rate

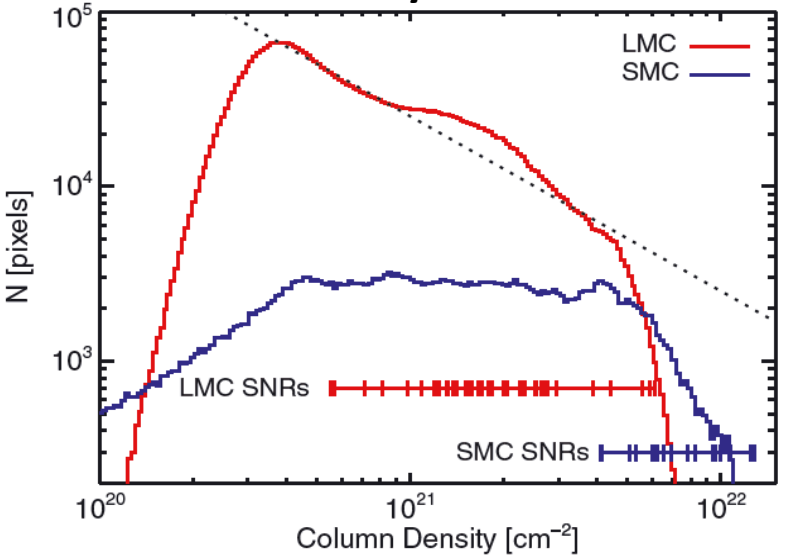
Badenes, Maoz & Draine (2010)

Need visibility times of SNR surveys to measure SN rate

SNR sizes

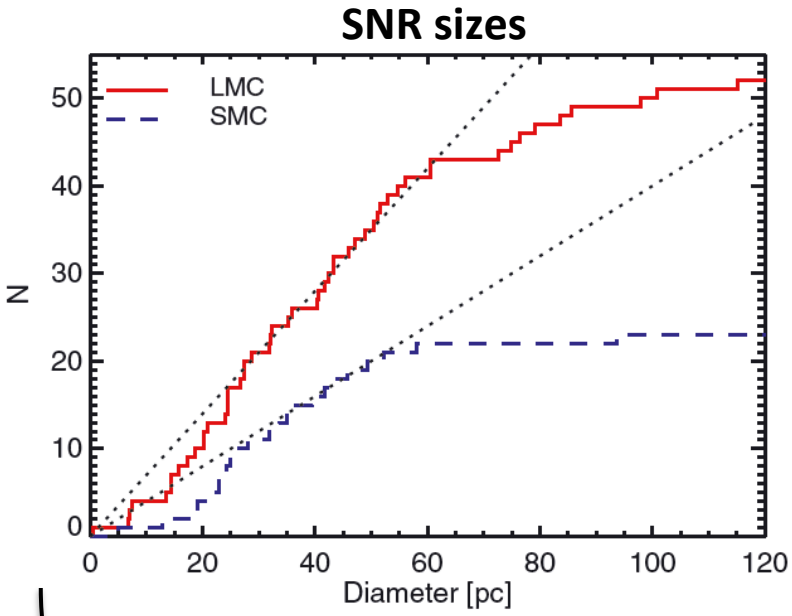


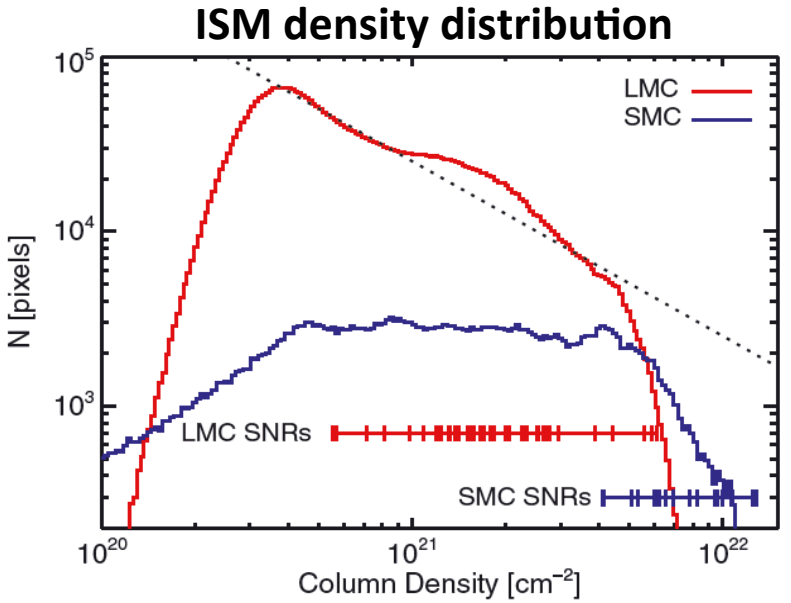
ISM density distribution



Badenes, Maoz & Draine (2010)

Need visibility times of SNR surveys to measure SN rate





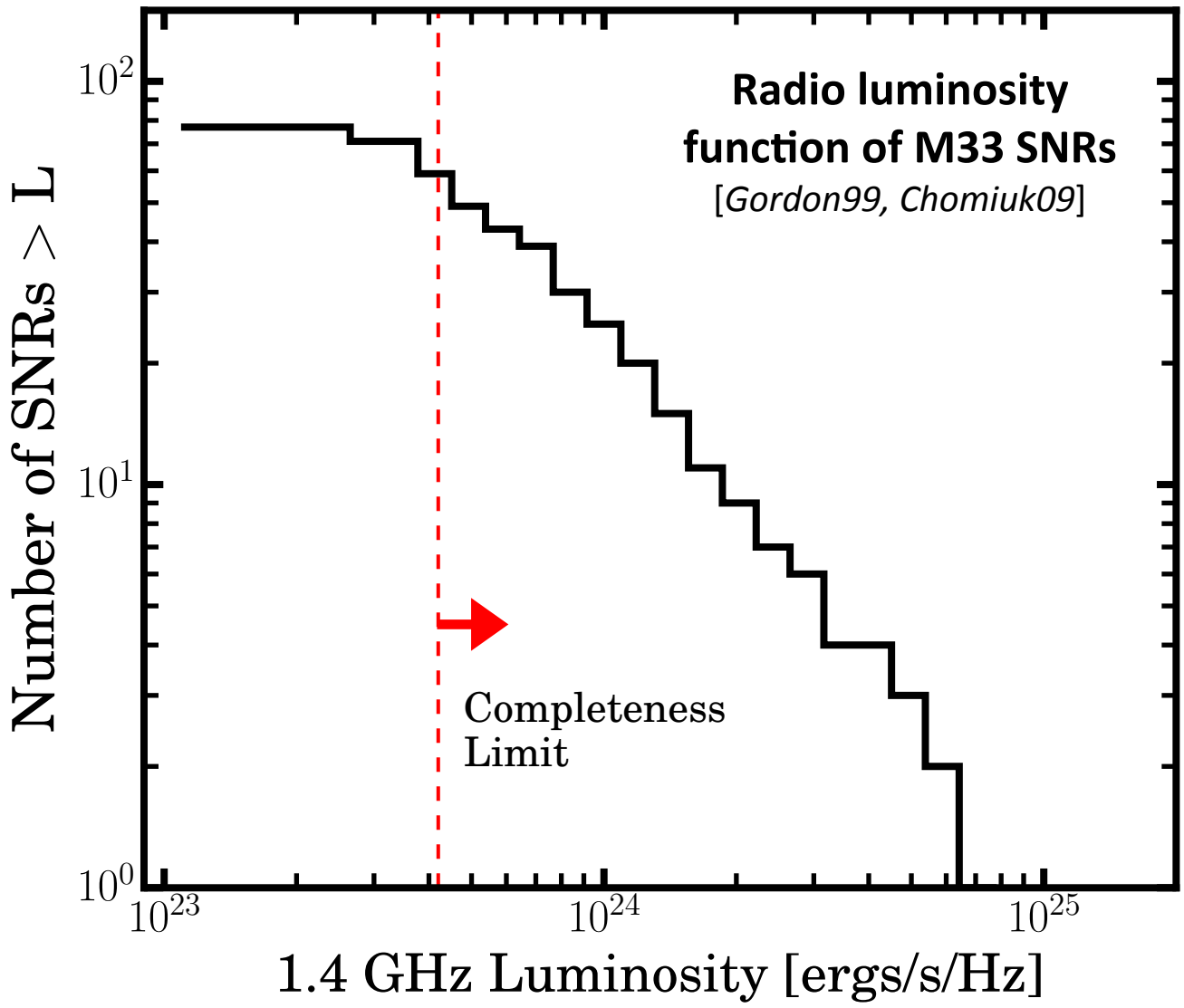
Visibility time ≈ Sedov-Taylor lifetime

Badenes, Maoz & Draine (2010)

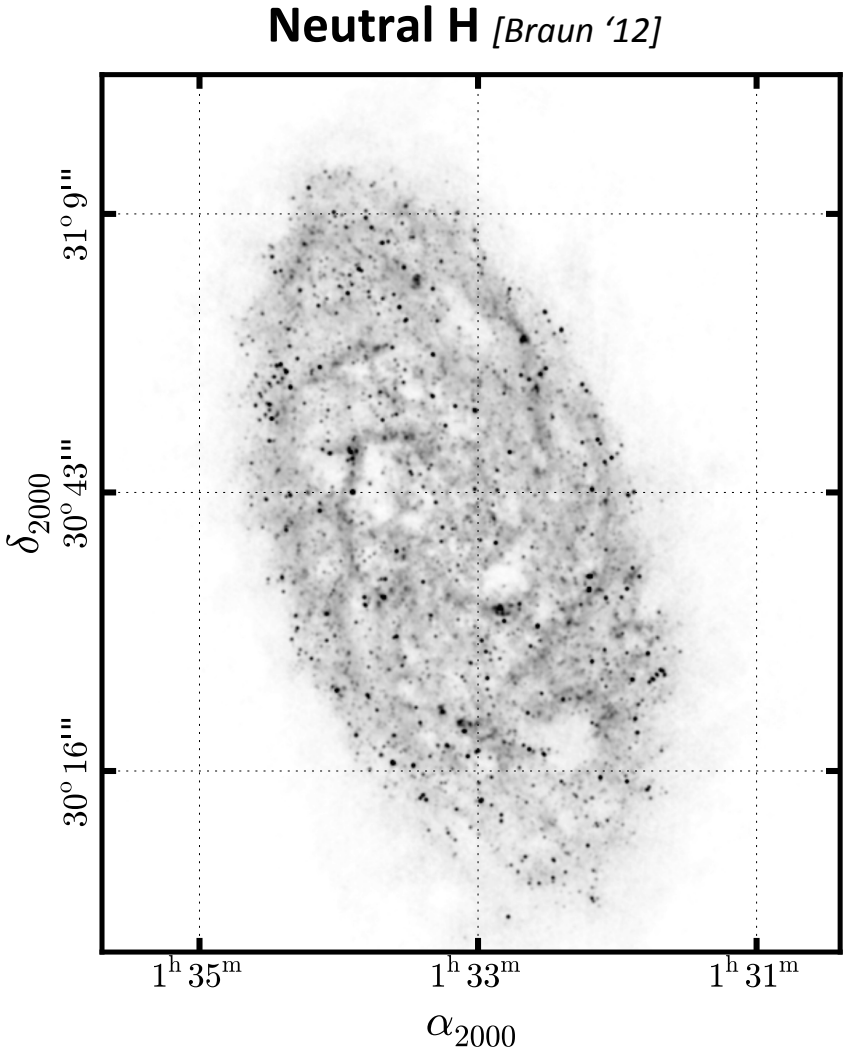
MY GOAL

Estimate visibility times by simulating an SNR survey

Model should reproduce existing observations



Simulate SNR population in the measured ISM



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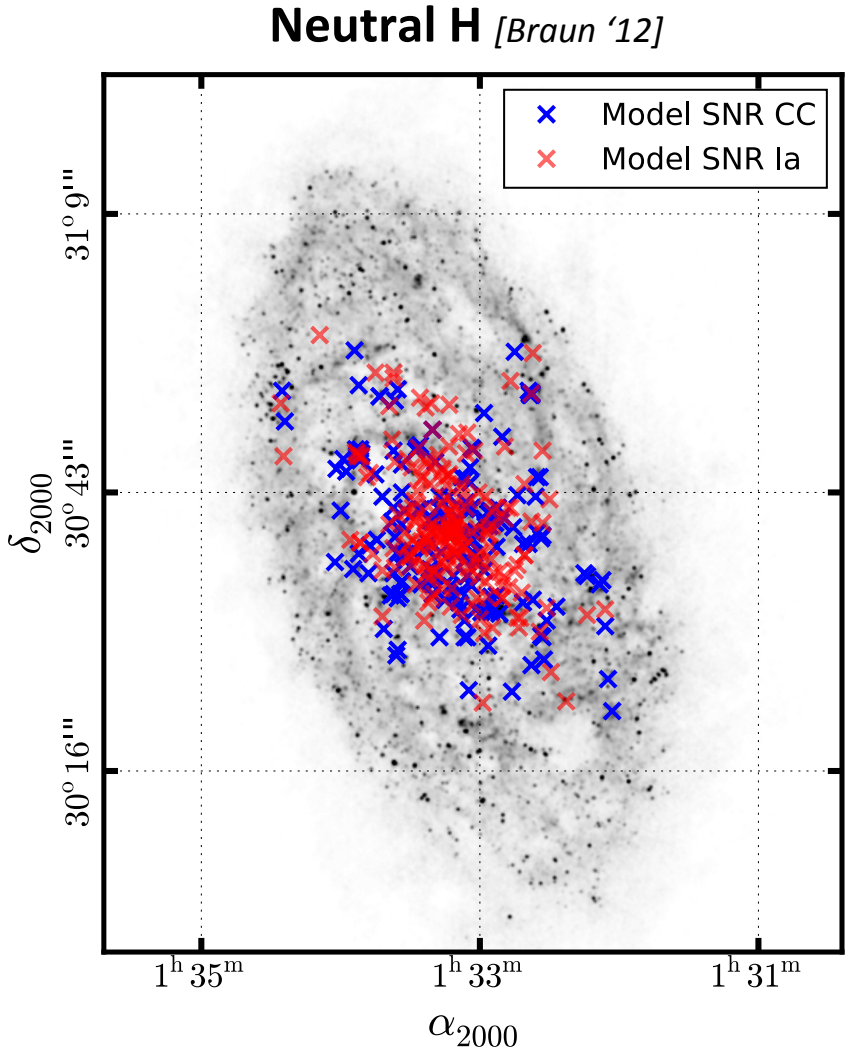
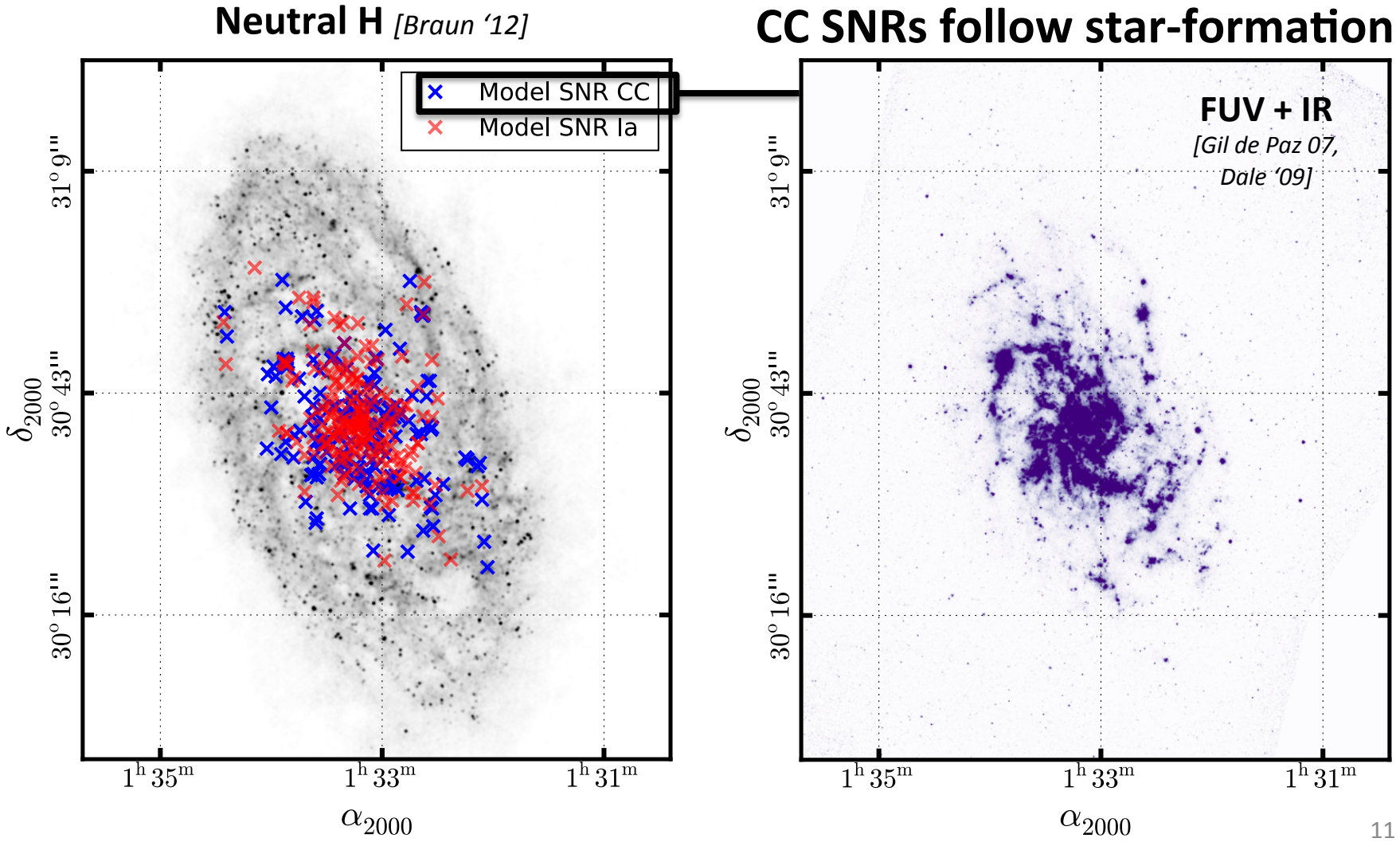


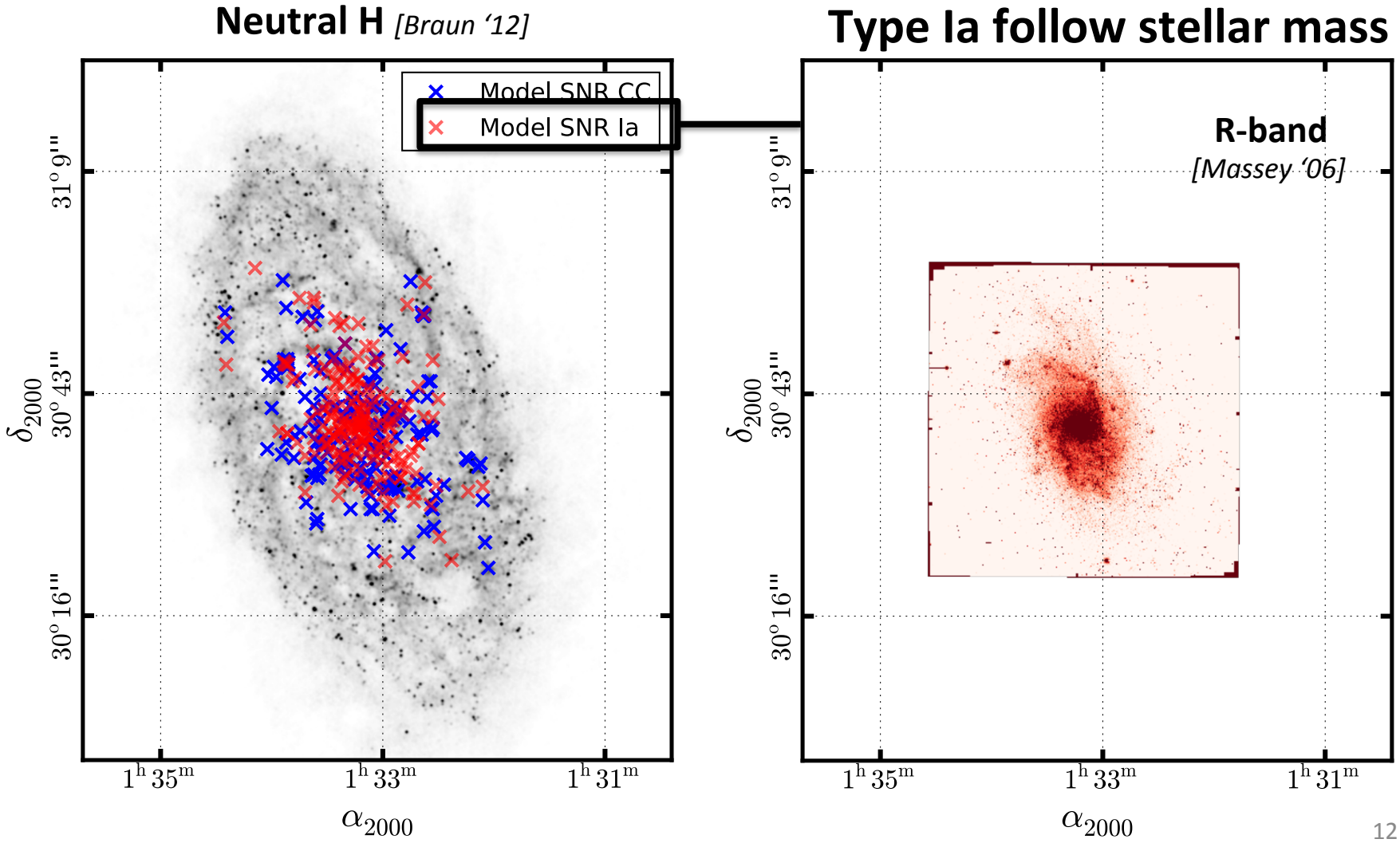
Parameters

1. SN Rate
2. HI Scale Height
3. Electron acceleration efficiency

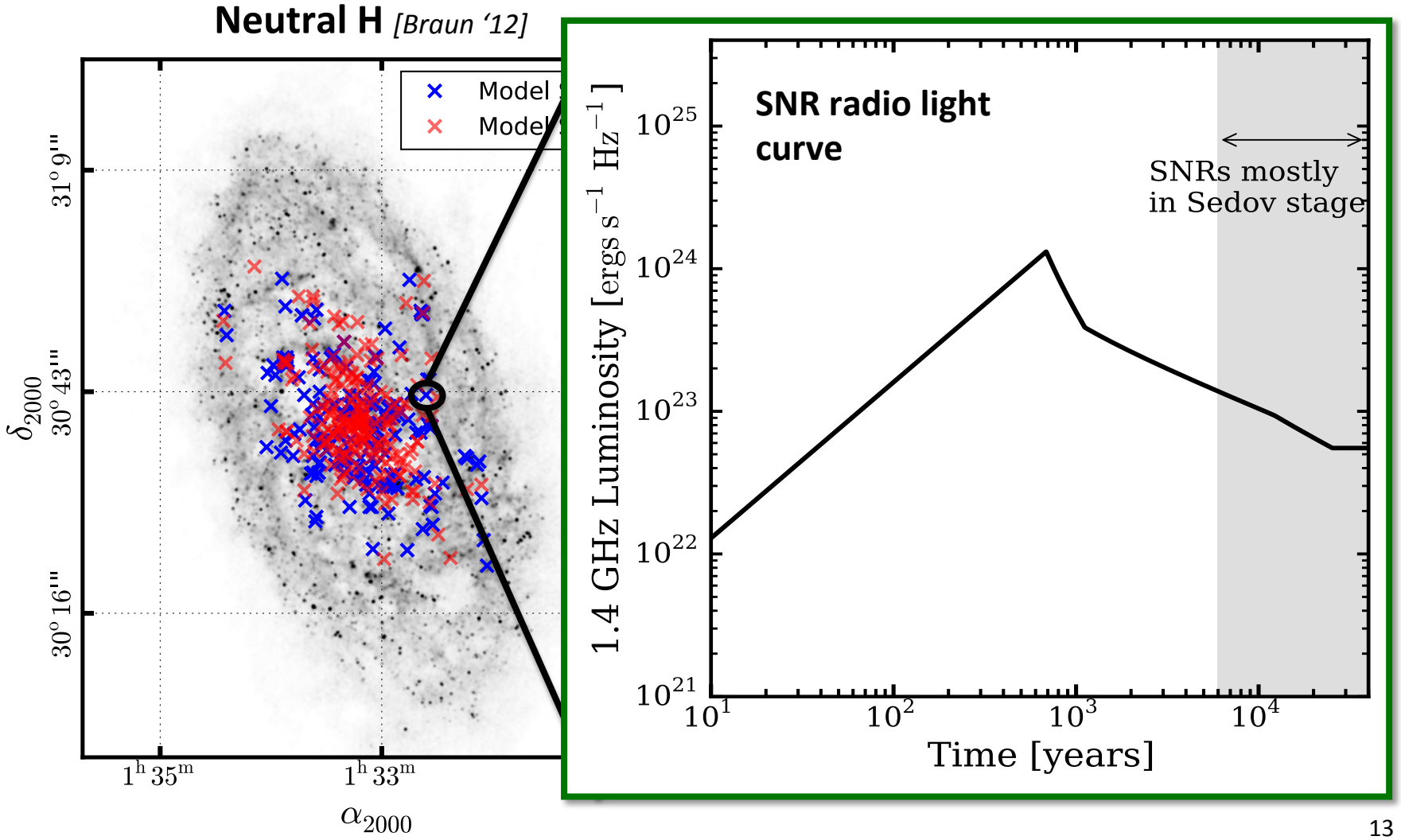
Simulate population of SNRs in the measured ISM of M33



Simulate population of SNRs in the measured ISM of M33

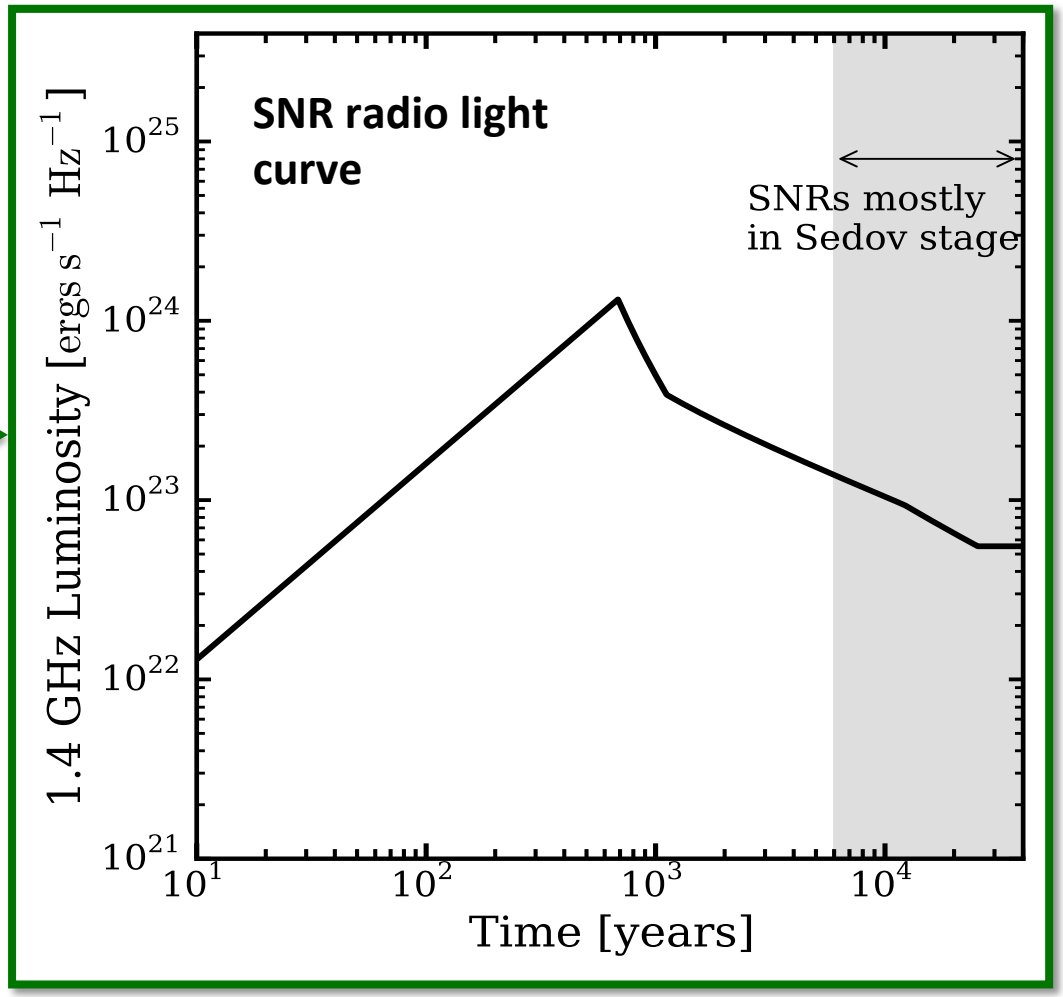


Simulate SNR population in the measured ISM

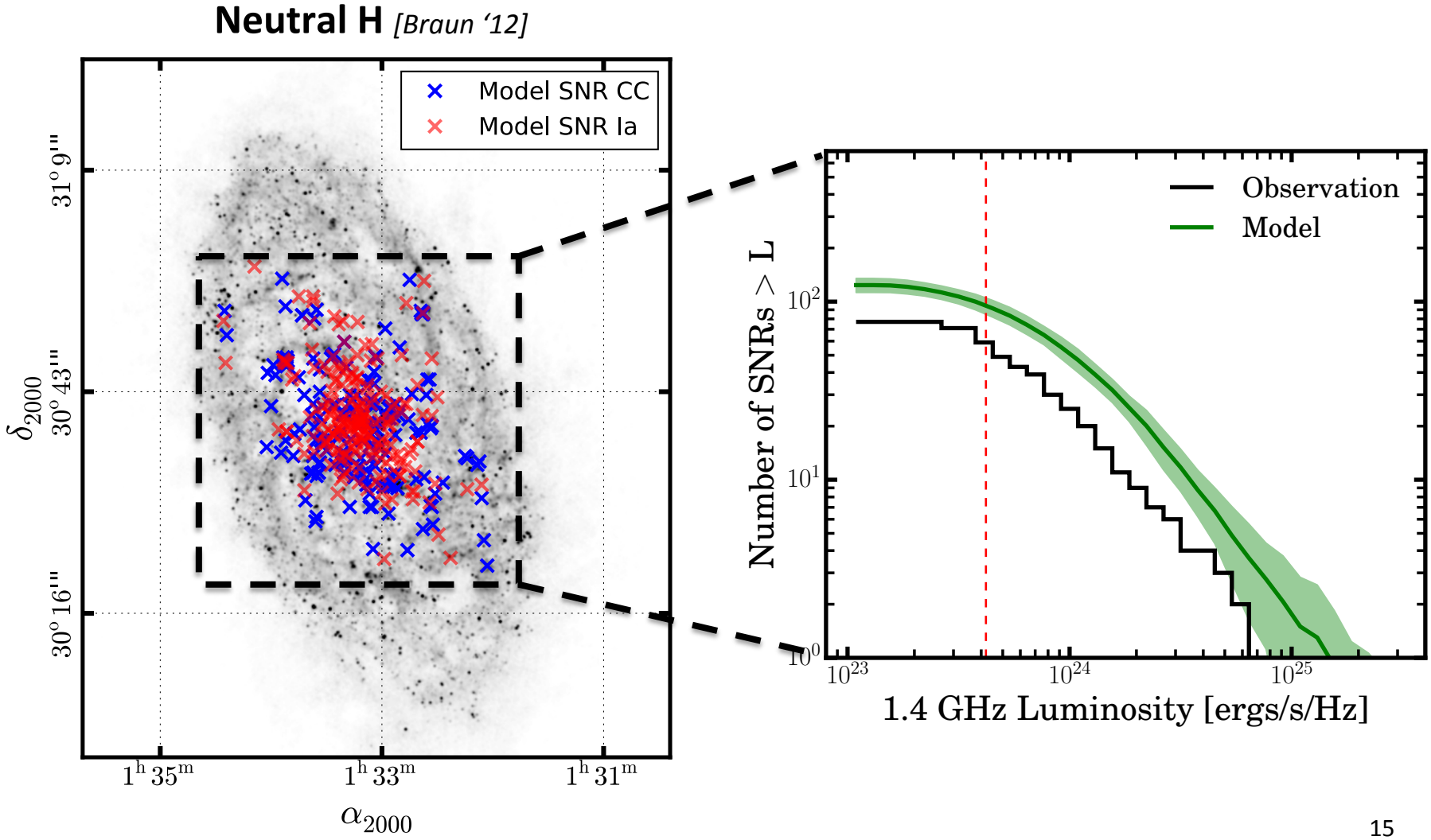


Simulate SNR population in the measured ISM

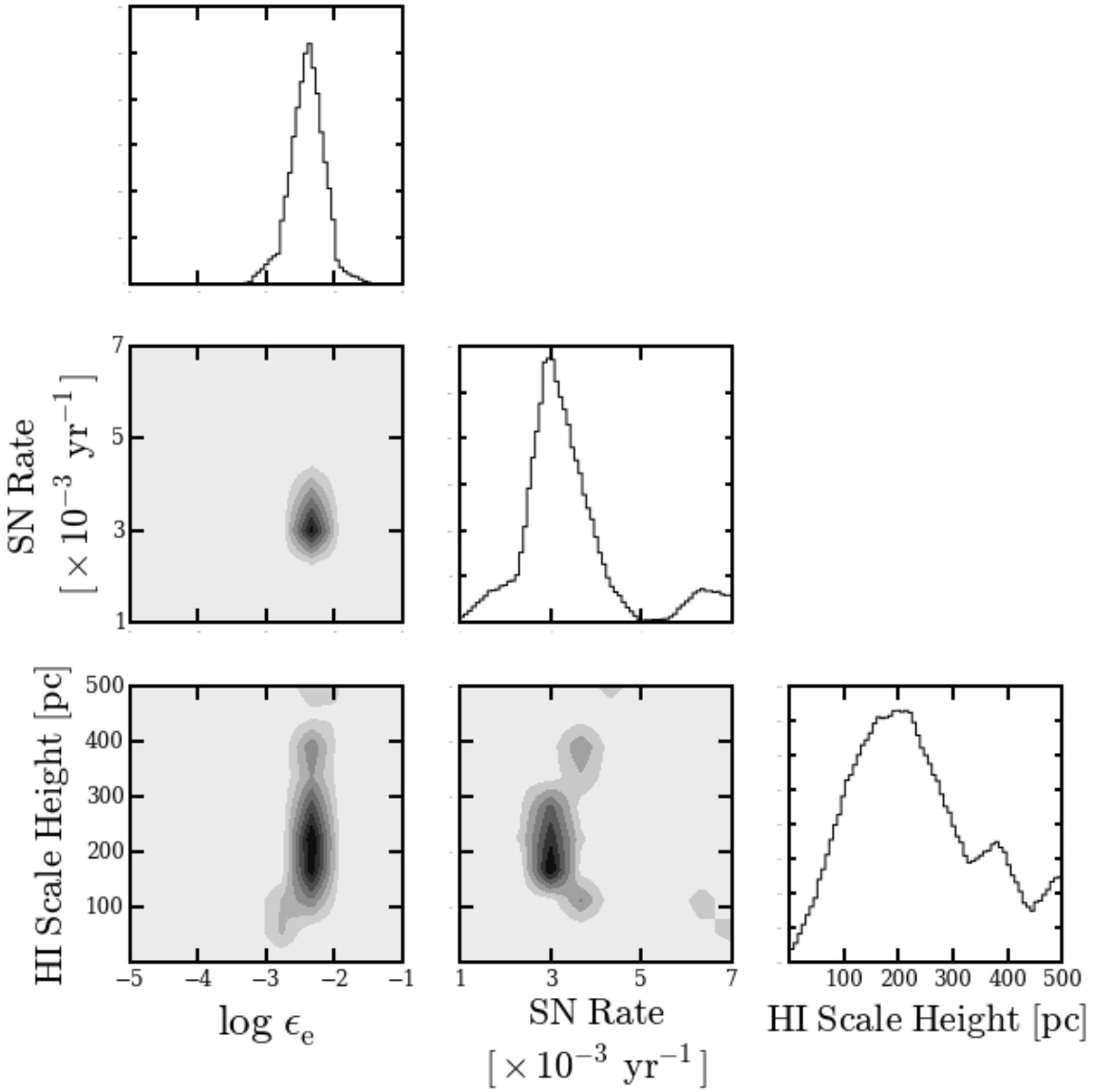
Resonant/non-resonant streaming instabilites
[Bell78, Bell04, Amato&Blasi09, Caprioli&Spitkovsky '12a,b,c]



Simulate SNR population in the measured ISM



M33 SNR catalog constrains our model parameter space



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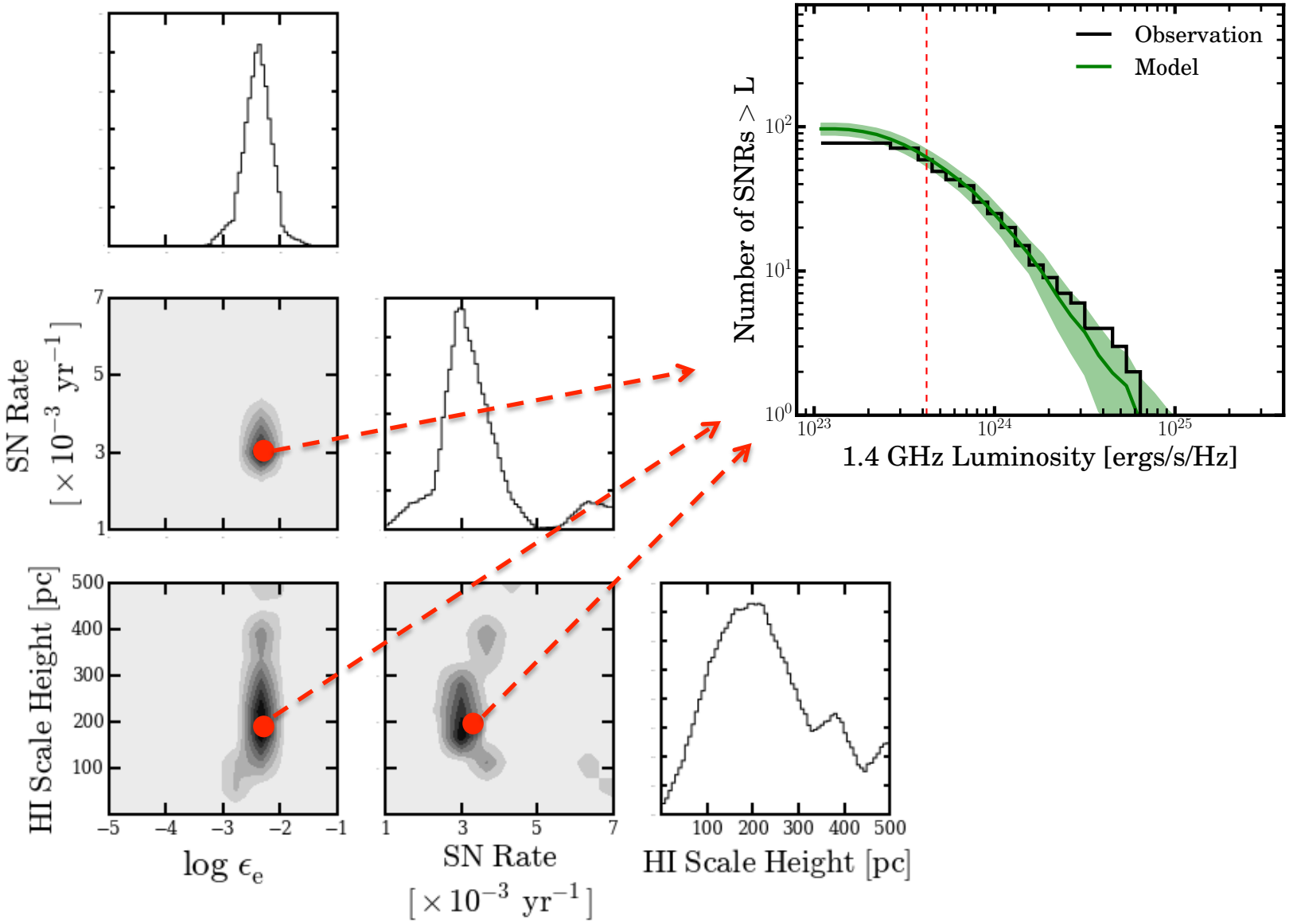

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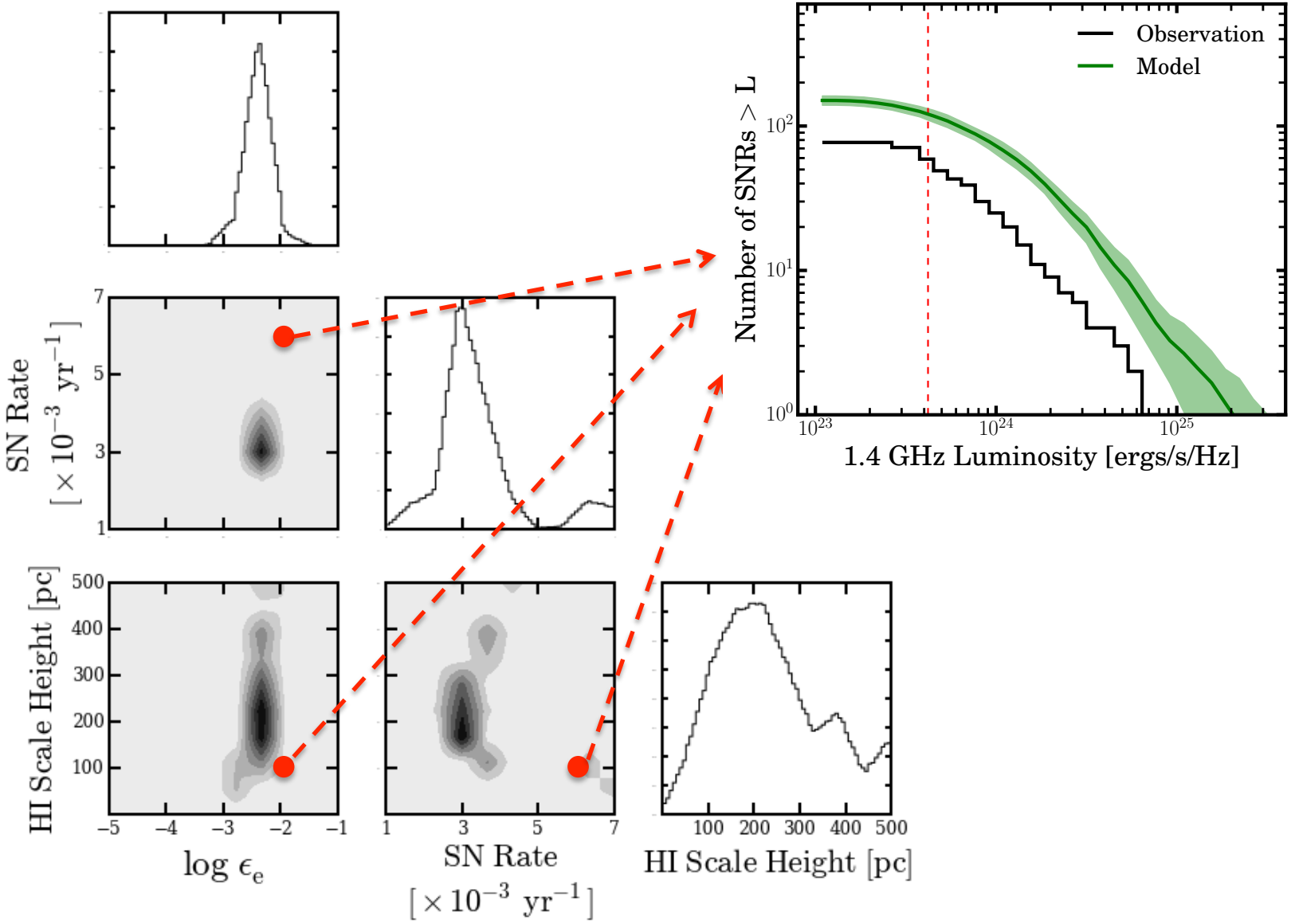

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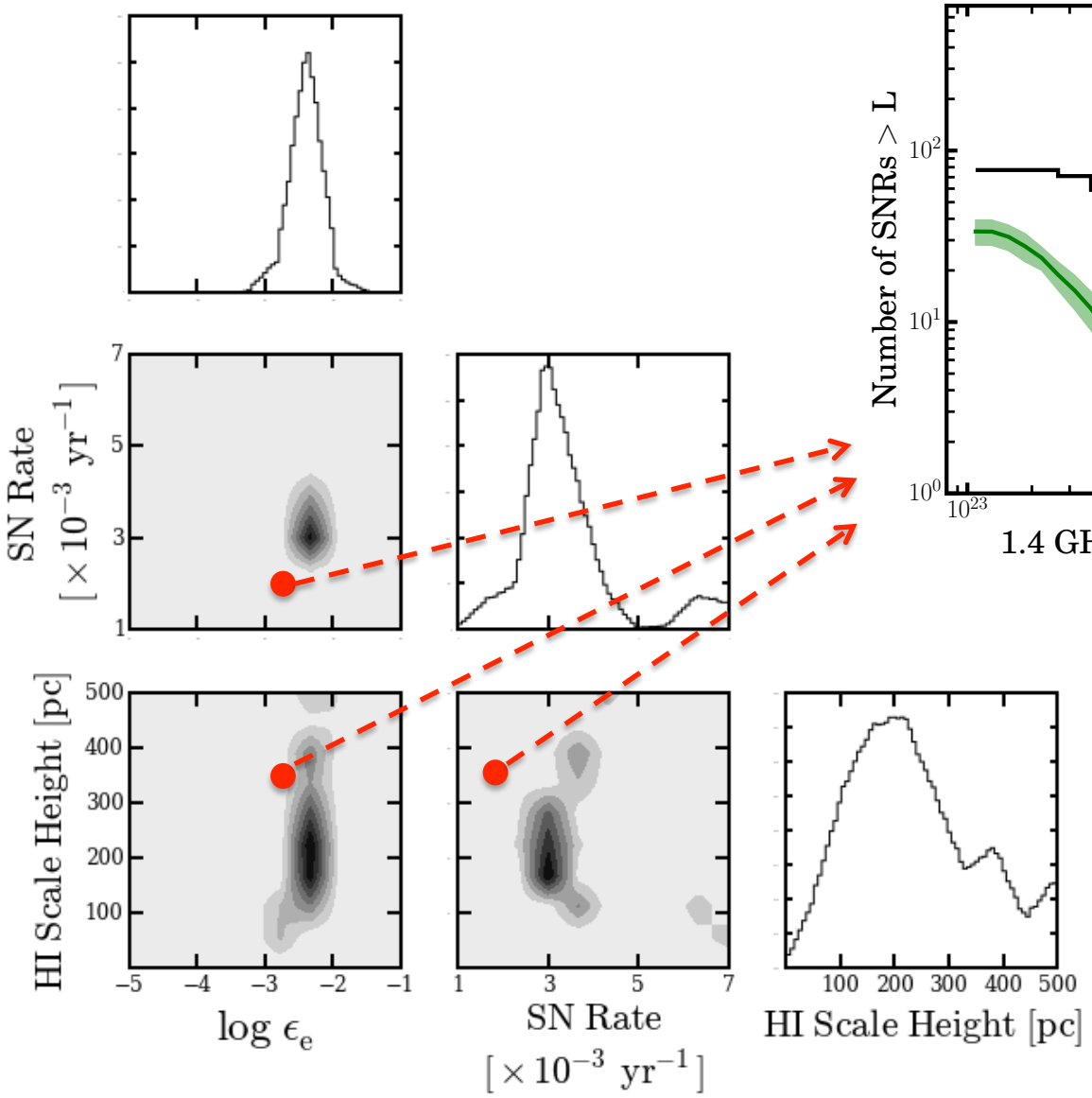
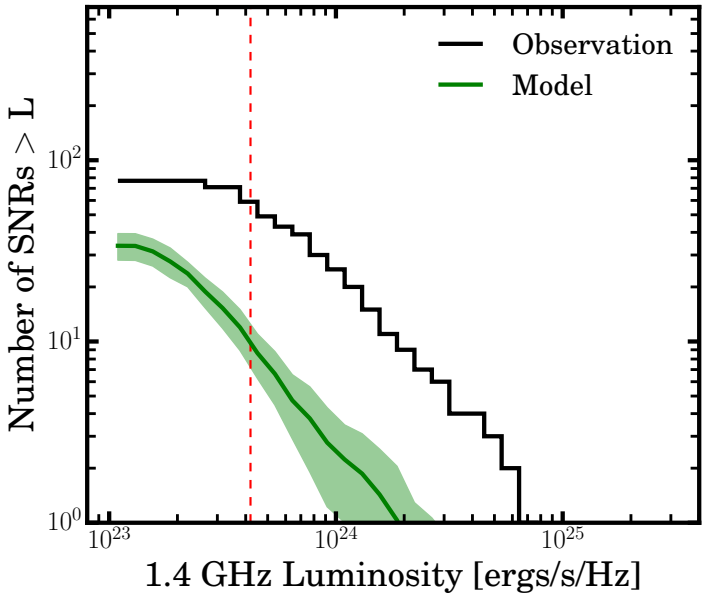
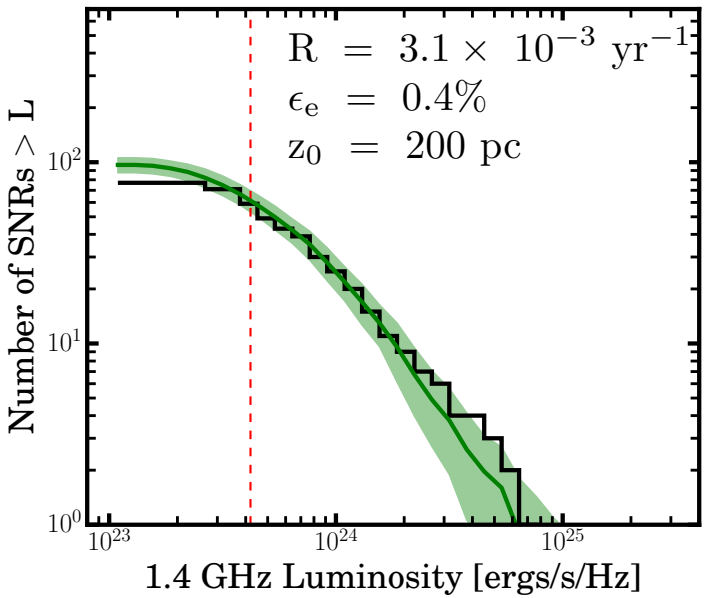
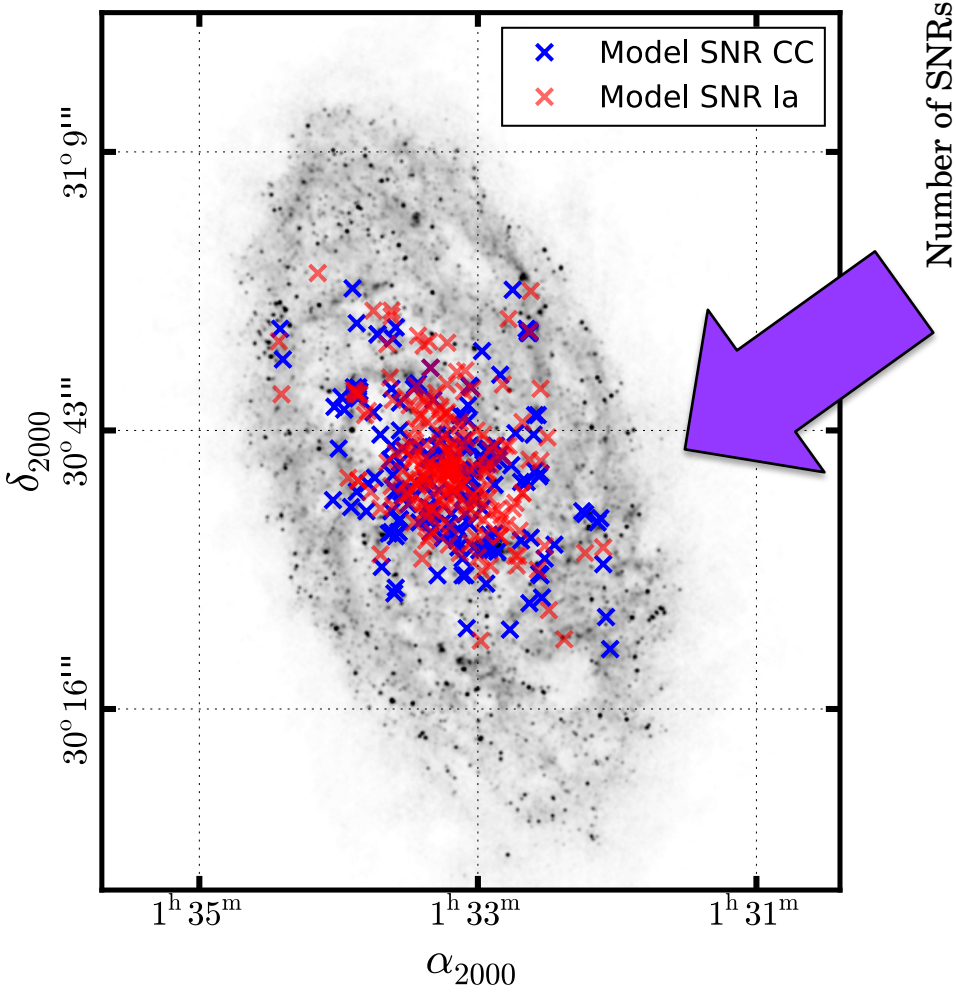
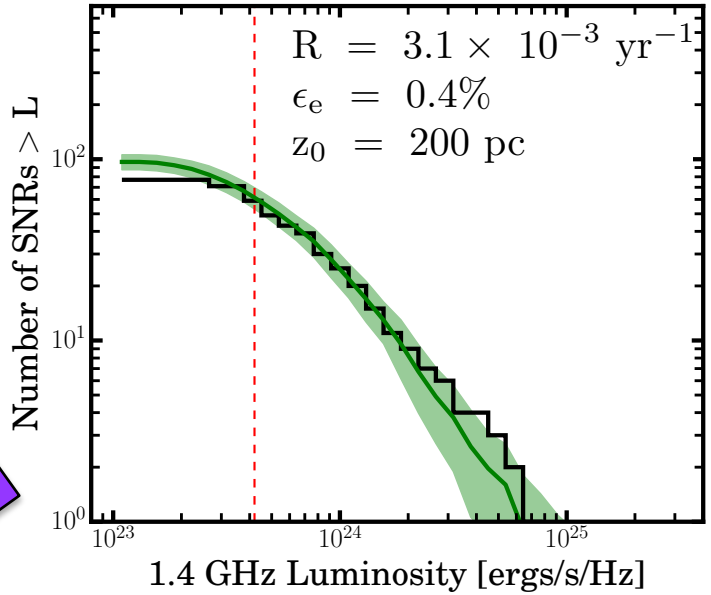




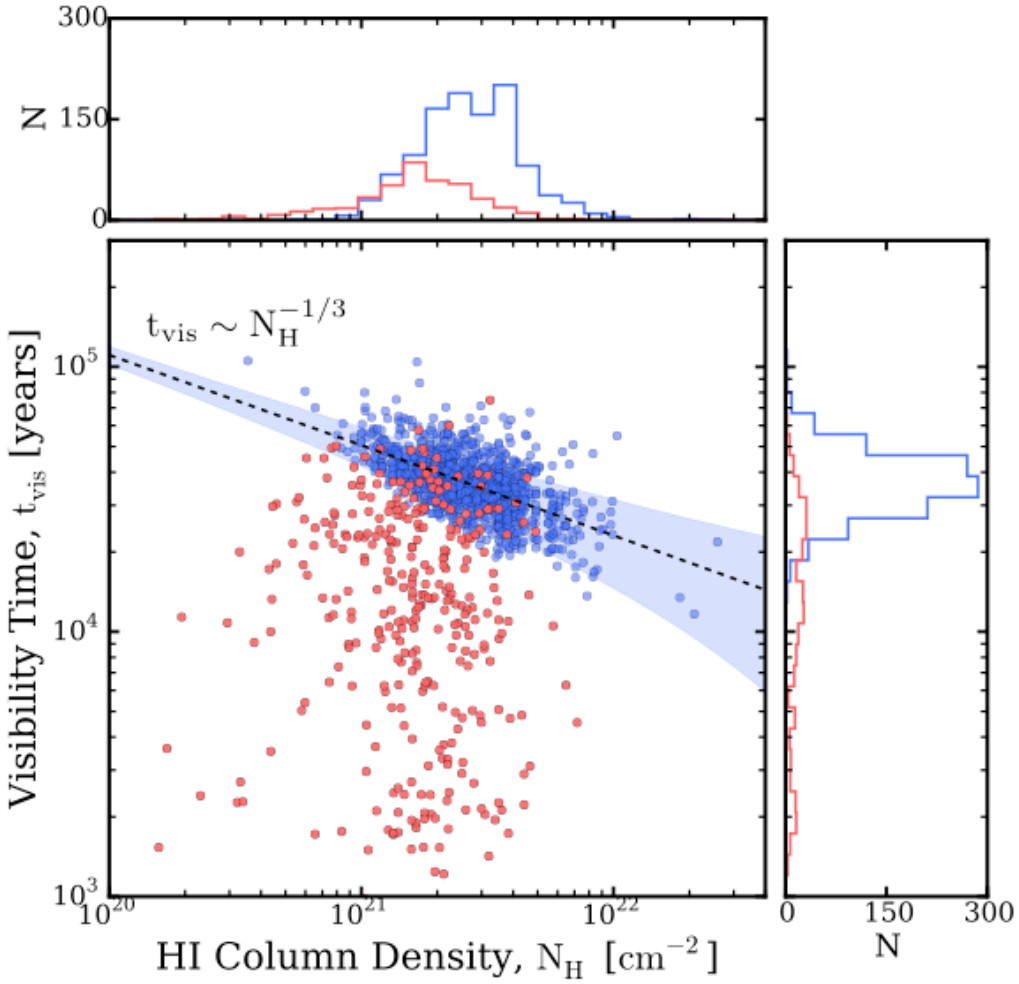

R = 3.1 × 10^−3 yr^−1
ϵe = 0.4%
z0 = 200 pc
Number of SNRs > L
10^2
10^1
10^0
10^23
10^24
10^25
1.4 GHz Luminosity [ergs/s/Hz]

Remake SNR population





We obtain a data-constrained estimate of SNR visibility times



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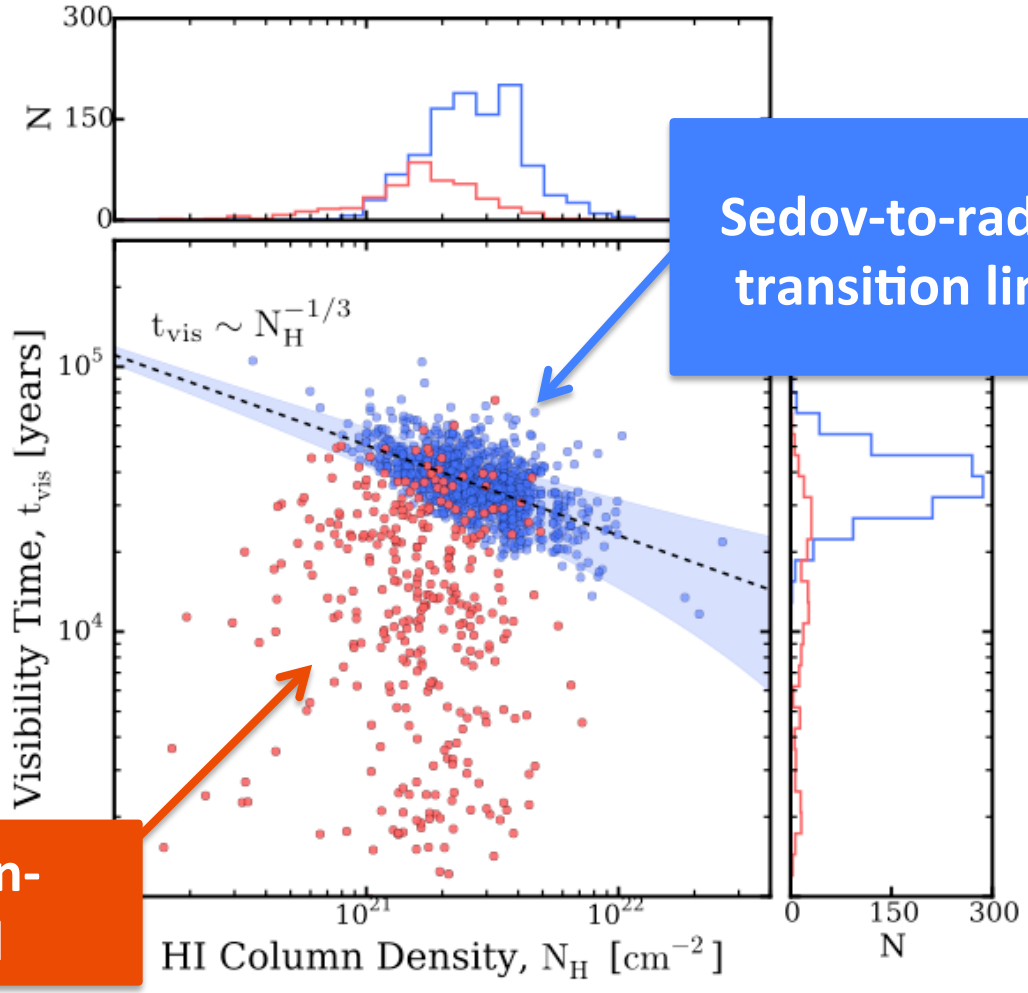


Sedov-to-radiative transition limited

Detection-Limited

Towards a Local Group DTD…

A Radio Selected Supernova Remnant Catalog in the Magellanic Clouds

Danny Huizenga[1], Laura Chomiuk[1], Carles Badenes[2], Sumit Sarbadhicary[2]
[1]Michigan State University, [2]University of Pittsburgh

Motivation

Statistical studies of populations of supernova remnants (SNRs) require a homogeneous SNR population with well understood selection effects. Current catalogs of SNRs in the Magellanic Clouds (MCs) have been compiled from detections at various wavelengths (radio, optical, and x-ray) and therefore are not complete in any statistical sense. A set of selection criteria are defined here with the goal of creating a sample of SNRs suitable for population studies.

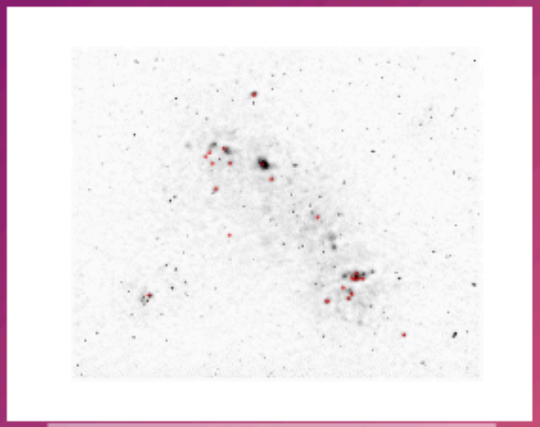
Methodology

Radio emission from supernova remnants is well understood when compared to other wavelengths and does not suffer from the effects of extinction. These qualities allow the following selection criteria to be implemented:

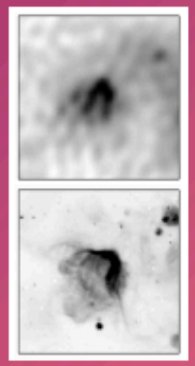
- 20 cm radio flux density > 5 sigma
- Spectral index, $\alpha < -0.2$ ($S_\nu \propto \nu^\alpha$)
- H-alpha counterpart (to eliminate background sources)

Additionally, all sources should be considered to avoid any bias in the sample. To accomplish this, sources should be identified in an automated manner.

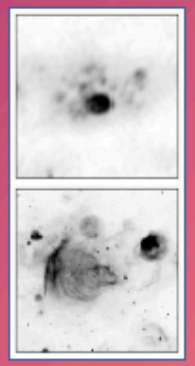
Sources were identified in 20 cm radio images (Wong et al.



20 cm radio map of the SMC (Wong et al. 2011)
SNRs from Badenes et al. (2010) are marked with red crosses.



Success
Top: 20 cm radio (Wong et al. 2011)
Bottom: Hα (Smith et al. 2005)
This SNR candidate in the SMC was identified through this process, but missed in previous catalogs. This shows how a radio selection criteria can find supernova remnants that may have been overlooked at other wavelengths.

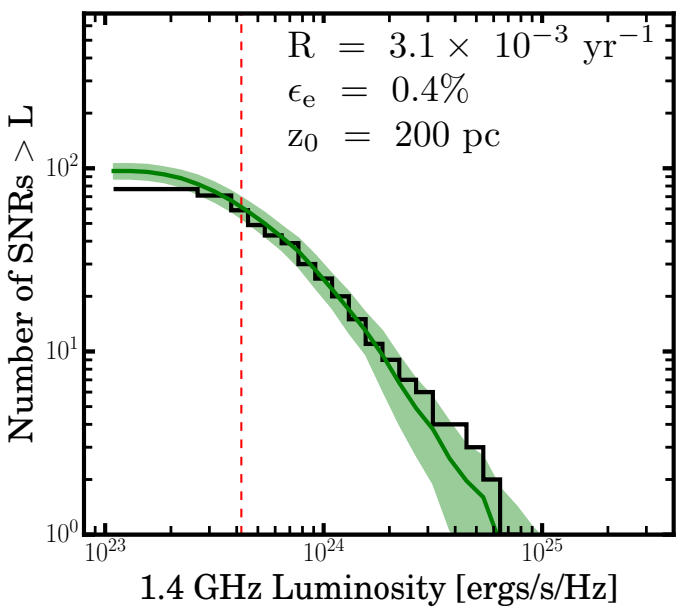


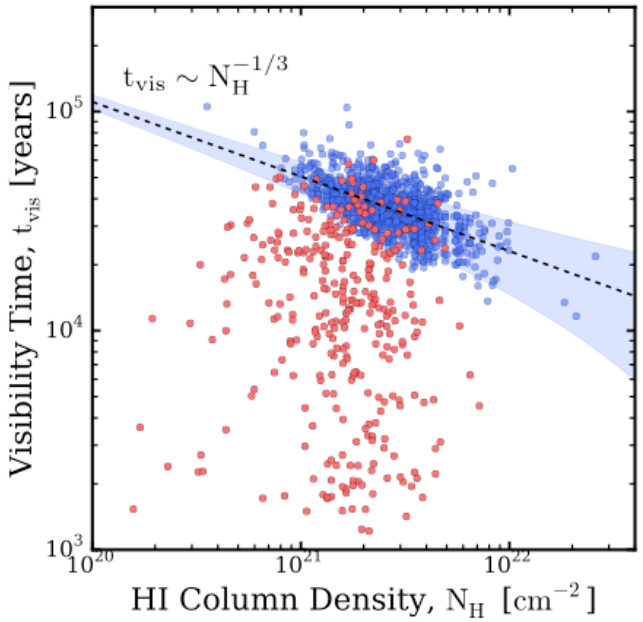
Failure
Top: 20 cm radio (Wong et al. 2011)
Bottom: Hα (Smith et al. 2005)
These images show a region containing five known SNRs. Only the dark region in the 20 cm image was identified using this method. This illustrates the inability for the Source Extractor program to properly segment a region of emission.

Daniel Huizenga's poster

Summary

Our model can reproduce the radio luminosity function and predict visibility times of an SNR survey

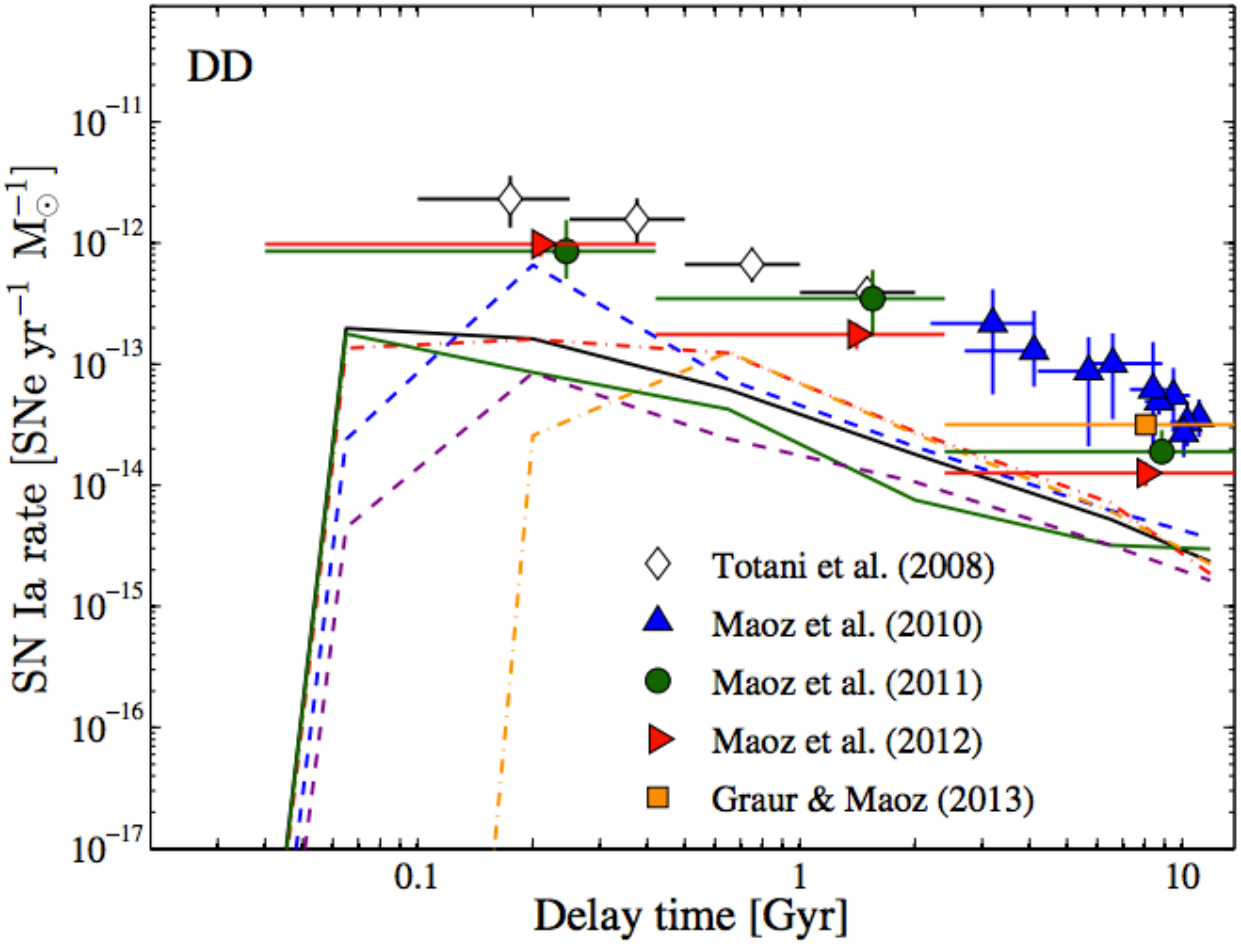




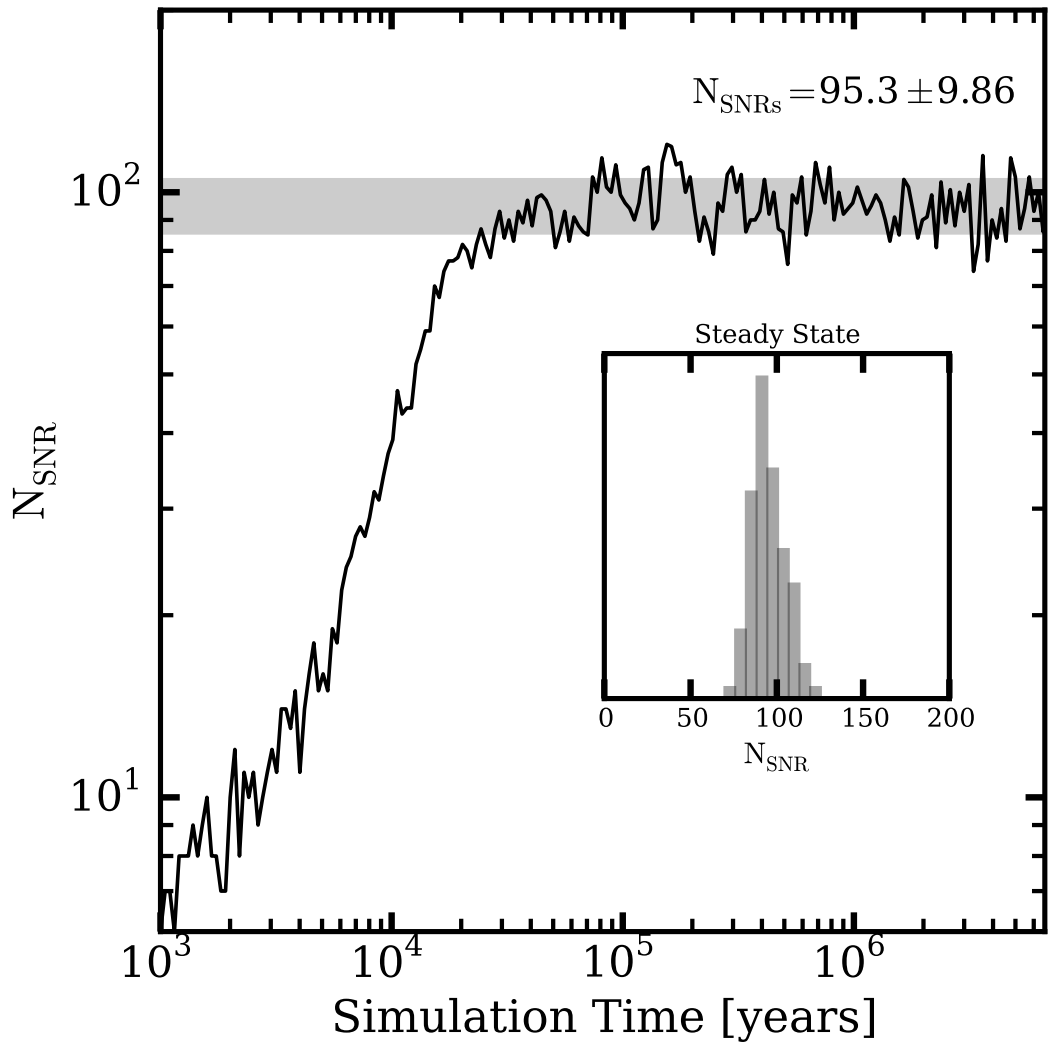
Next… SN rates and delay-time distribution in the Local Group galaxies

Back up slides

DTD of Type Ia SNe from SN surveys



Model SNR population



Simulate population of SNRs in the measured ISM of M33