

Title: Gamma rays from dark matter self-annihilation in a caustic in M31

Date: Jun 07, 2008 02:15 PM

URL: <http://pirsa.org/08060018>

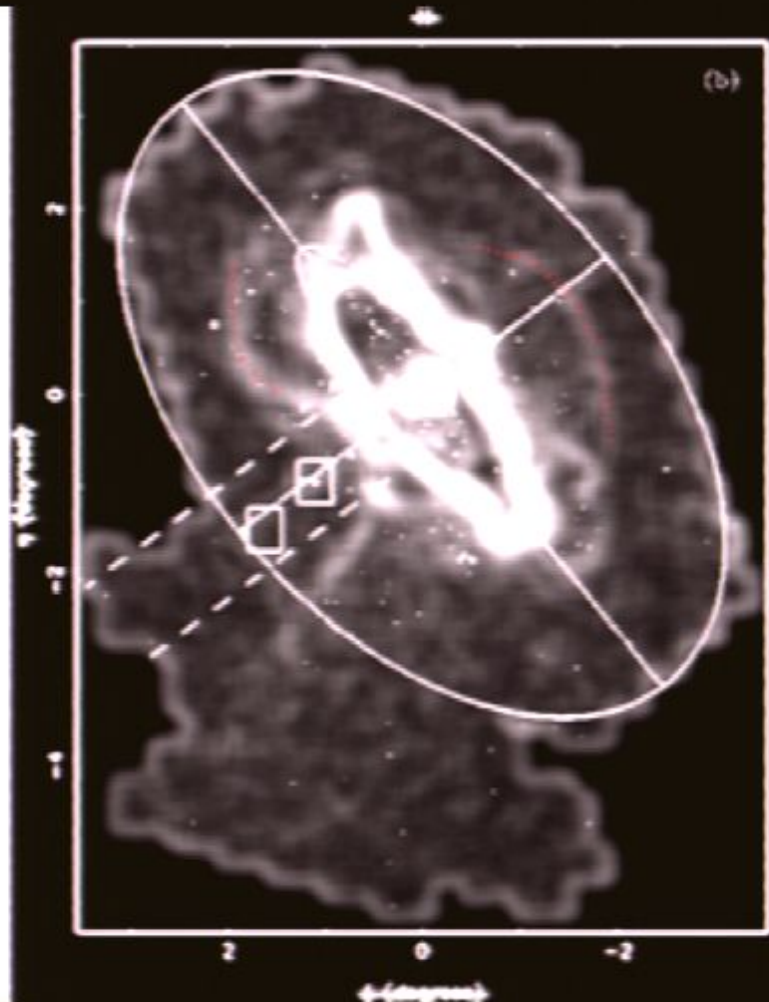
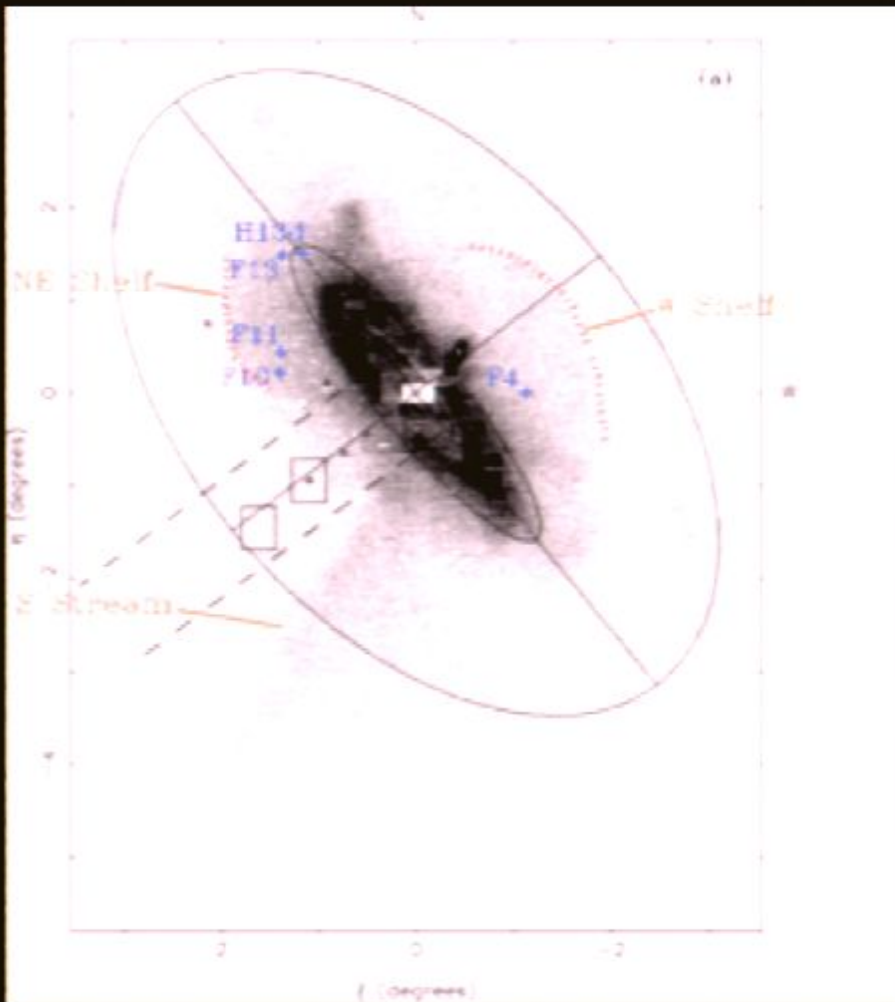
Abstract:

# Gamma rays from neutralino self-annihilation in a caustic in M31

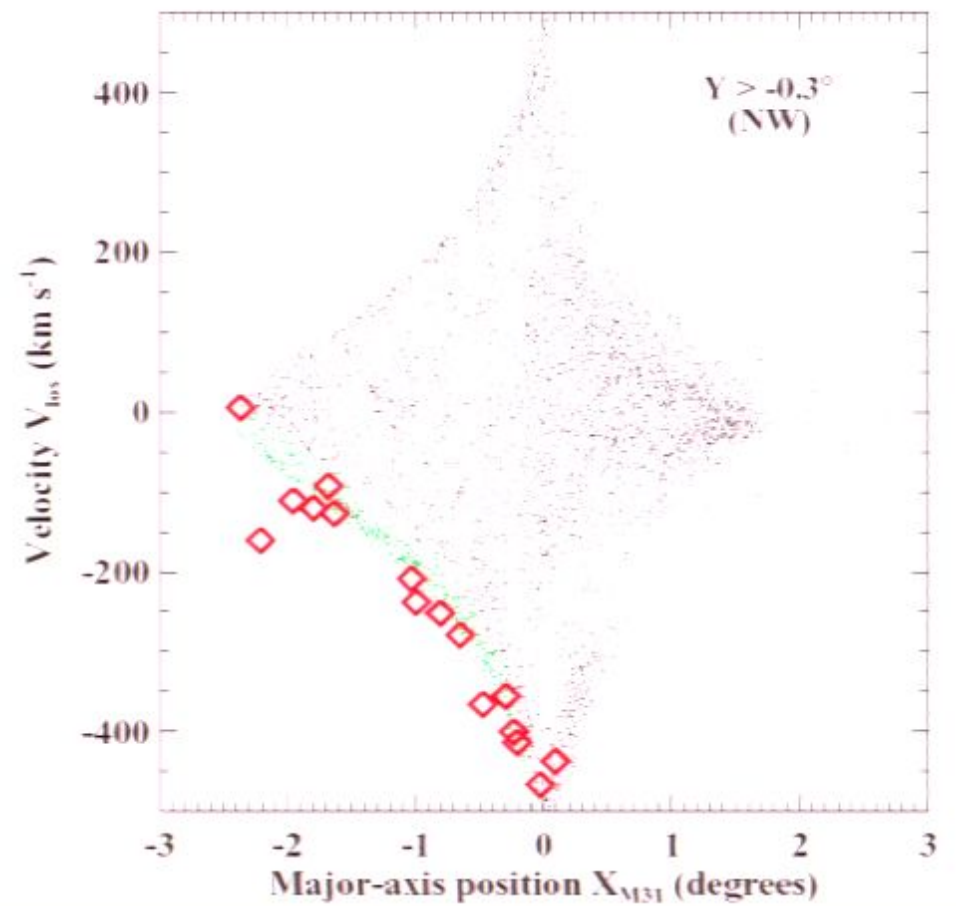
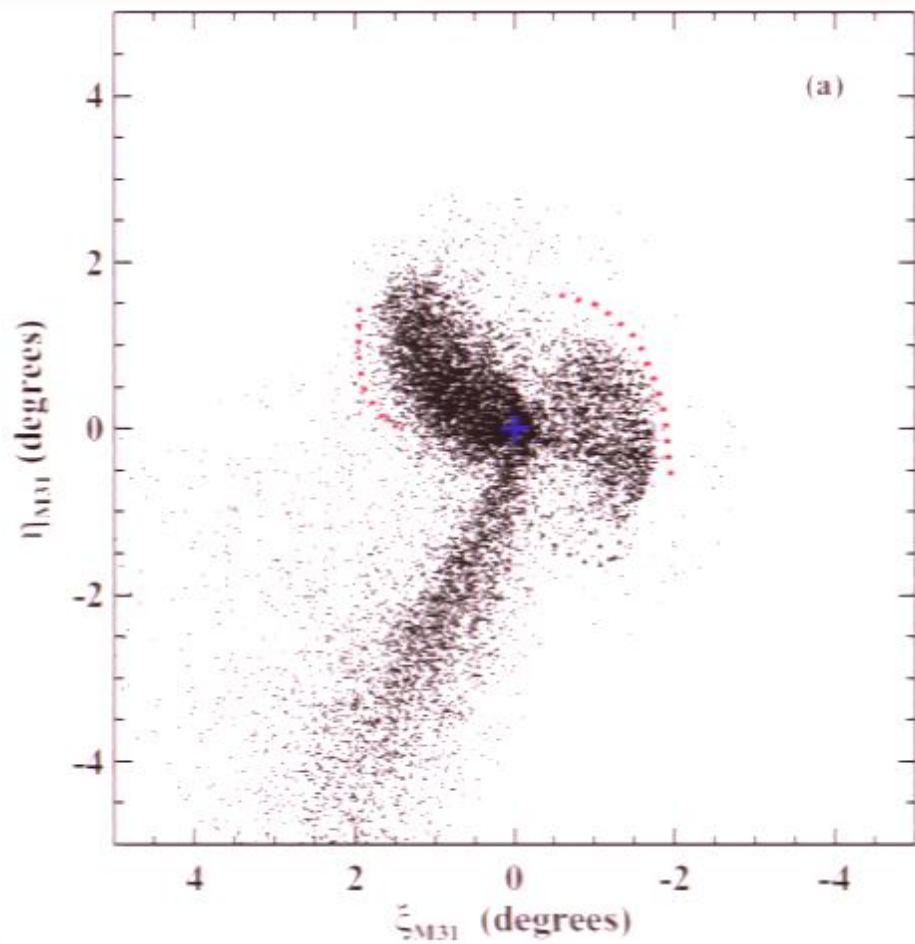
Robyn Sanderson  
MIT

Small Scale Structure of Dark Matter Workshop  
Perimeter Institute, 7 June 2008

$\eta$  (degrees North)

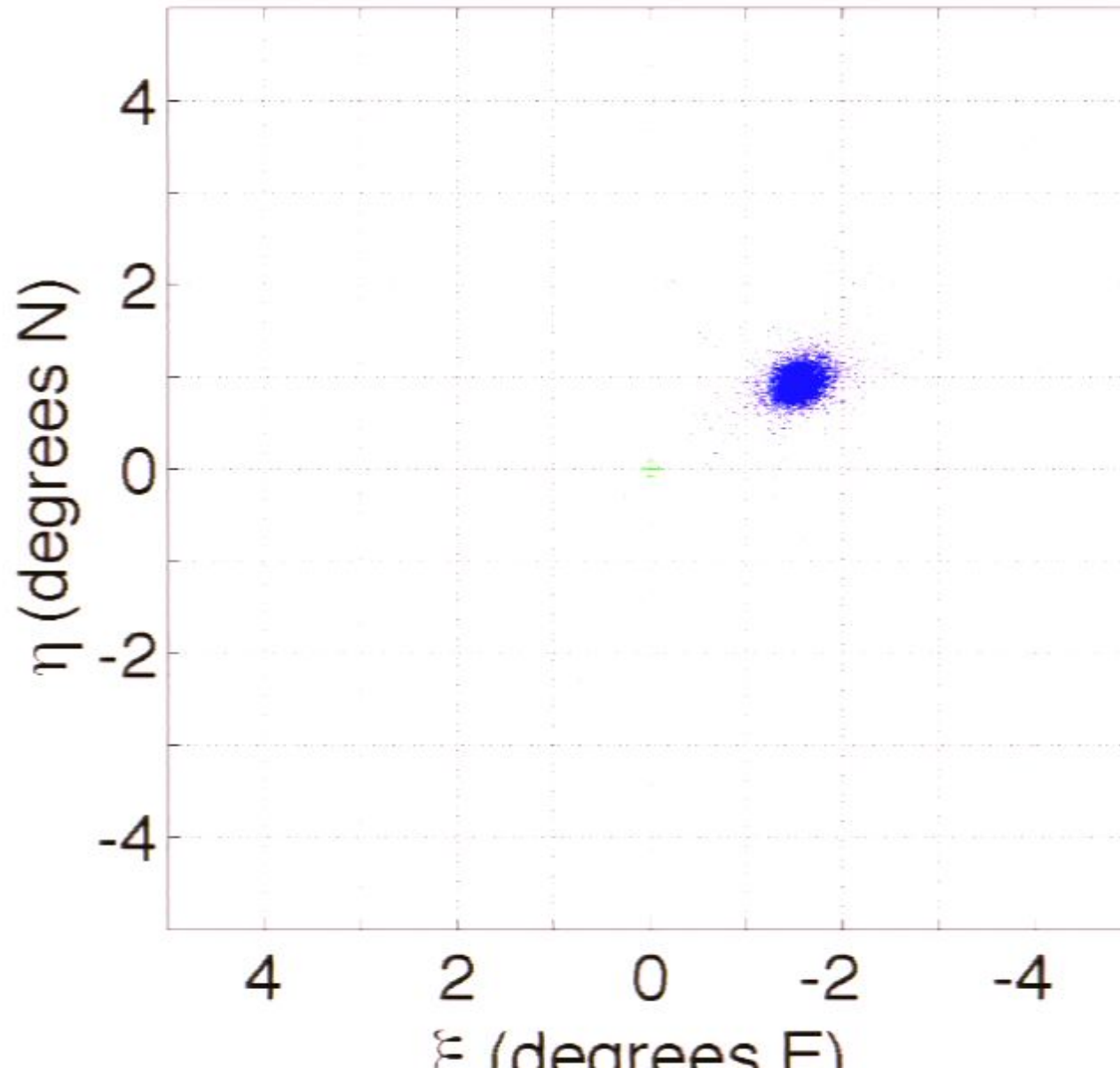


$\xi$  (degrees East)



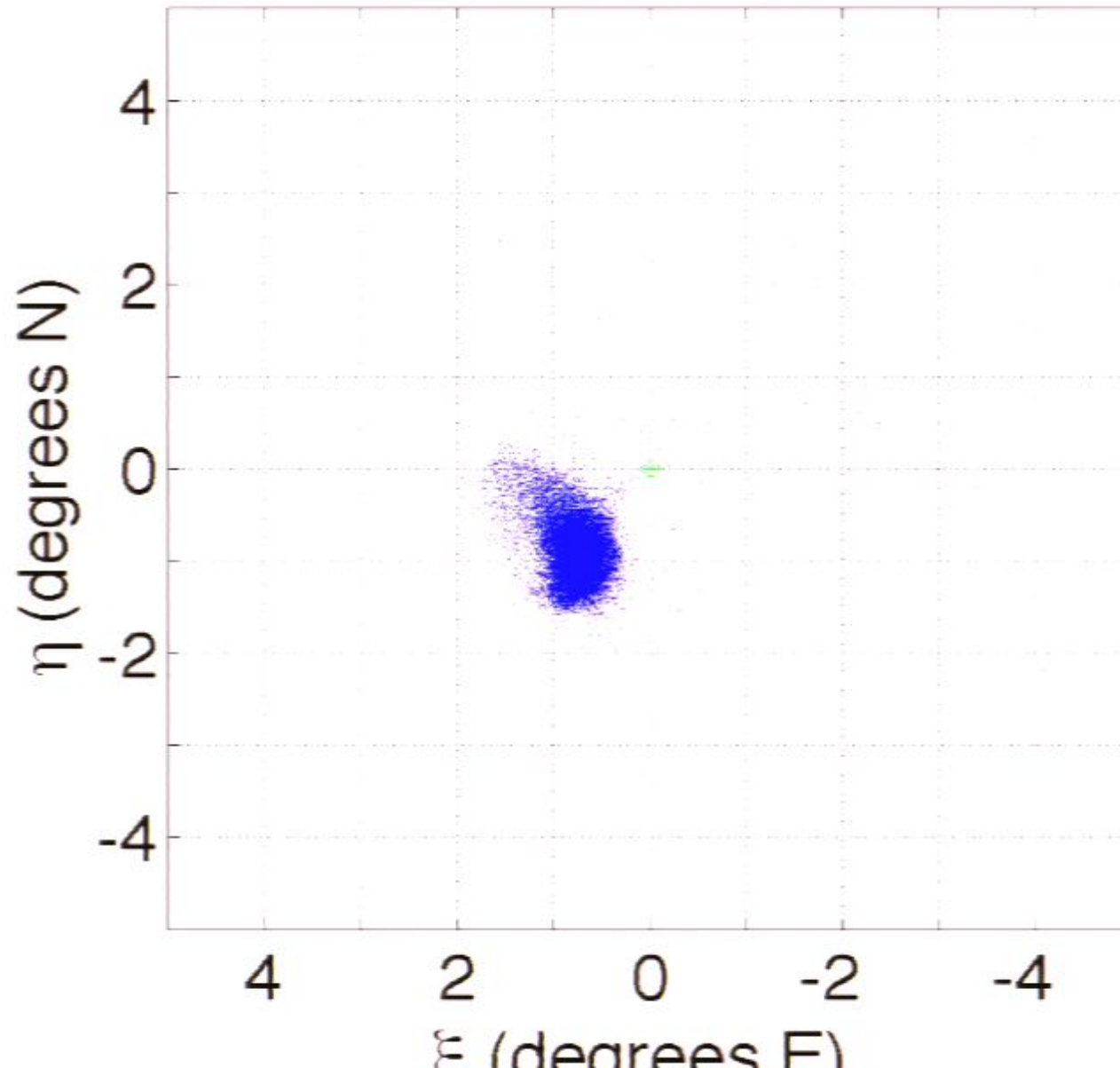
# Movie of merger in plane of sky

109.1 Myr



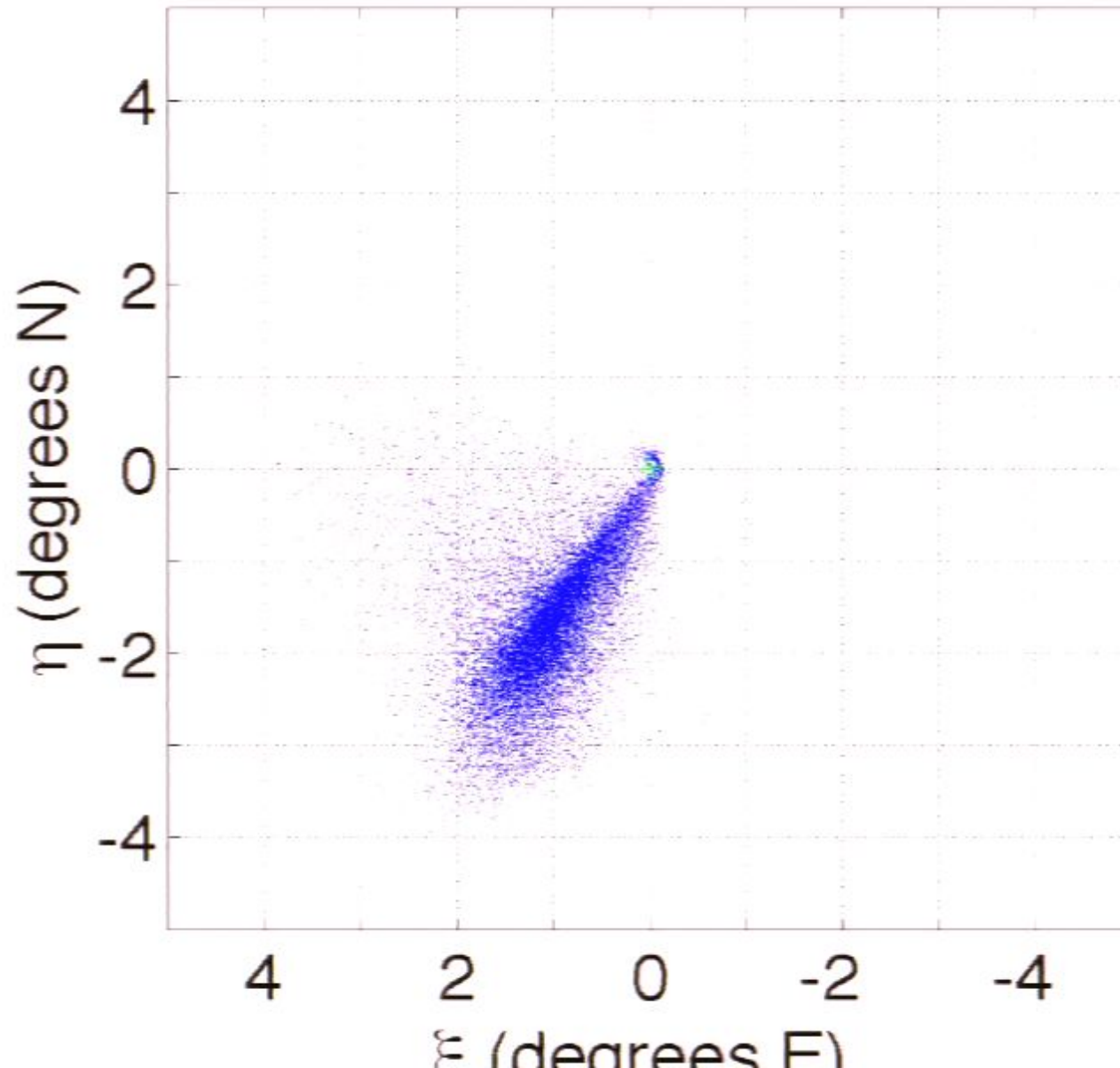
# Movie of merger in plane of sky

242.8 Myr



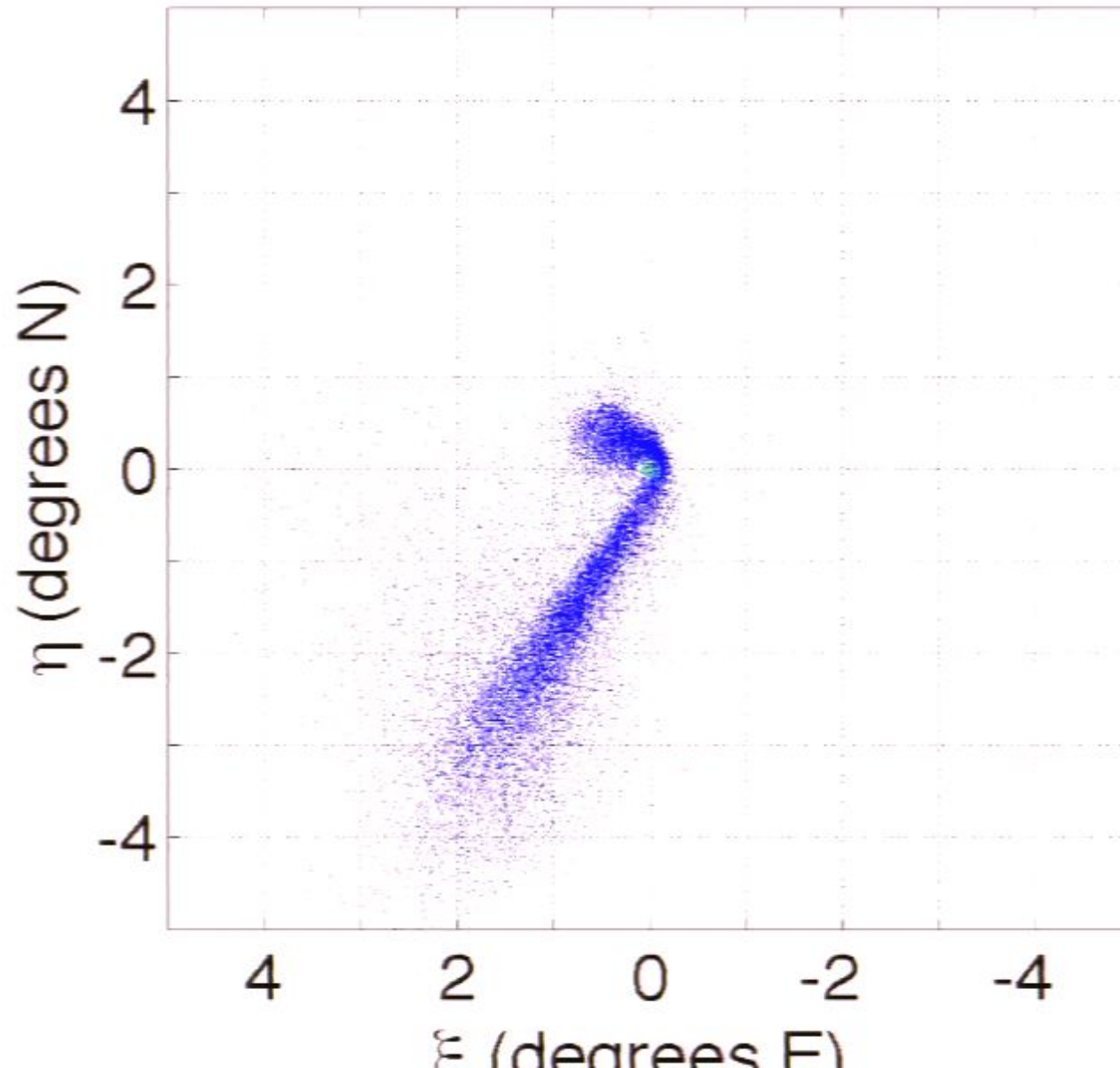
# Movie of merger in plane of sky

385.5 Myr



# Movie of merger in plane of sky

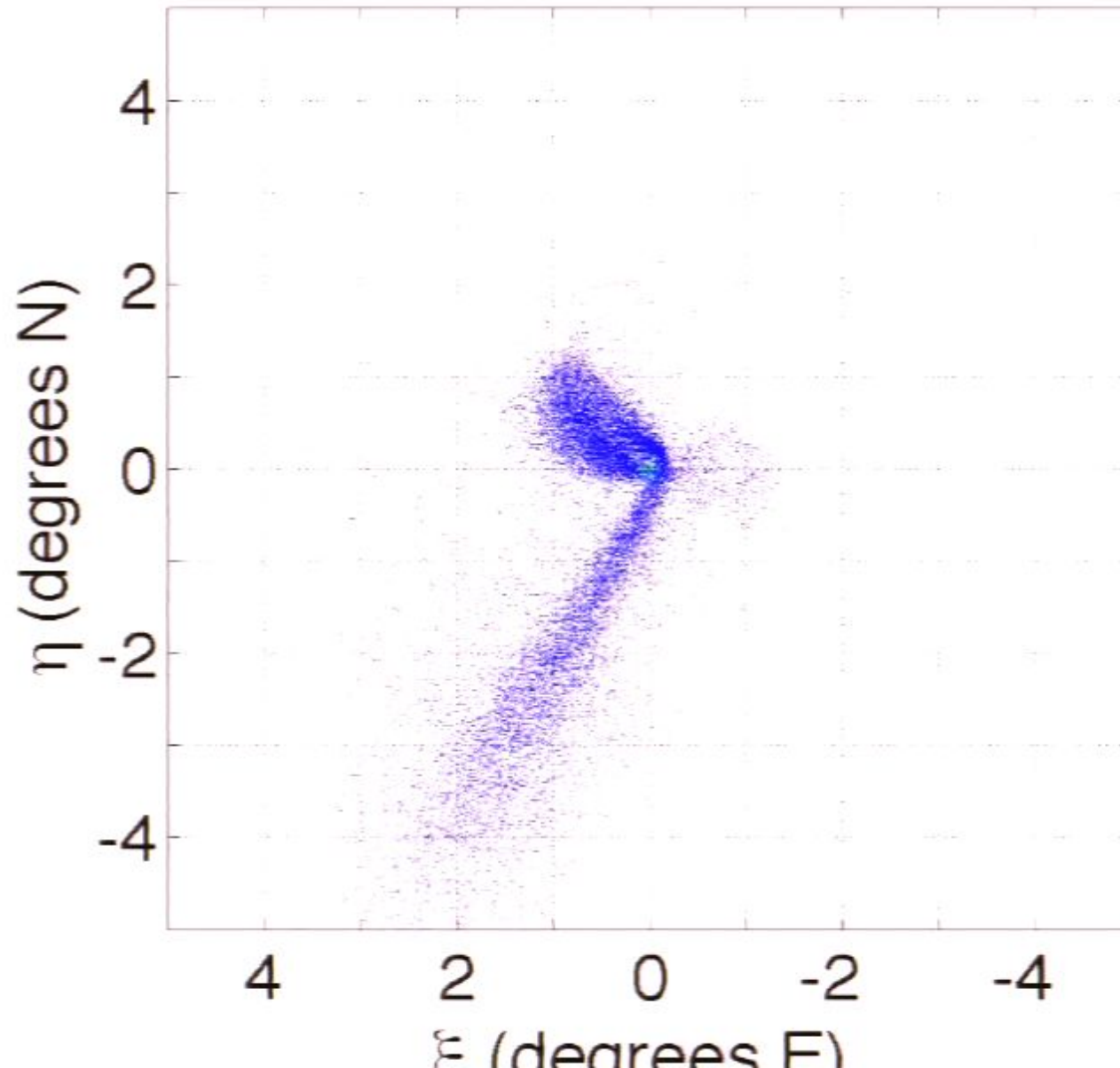
509.0 Myr





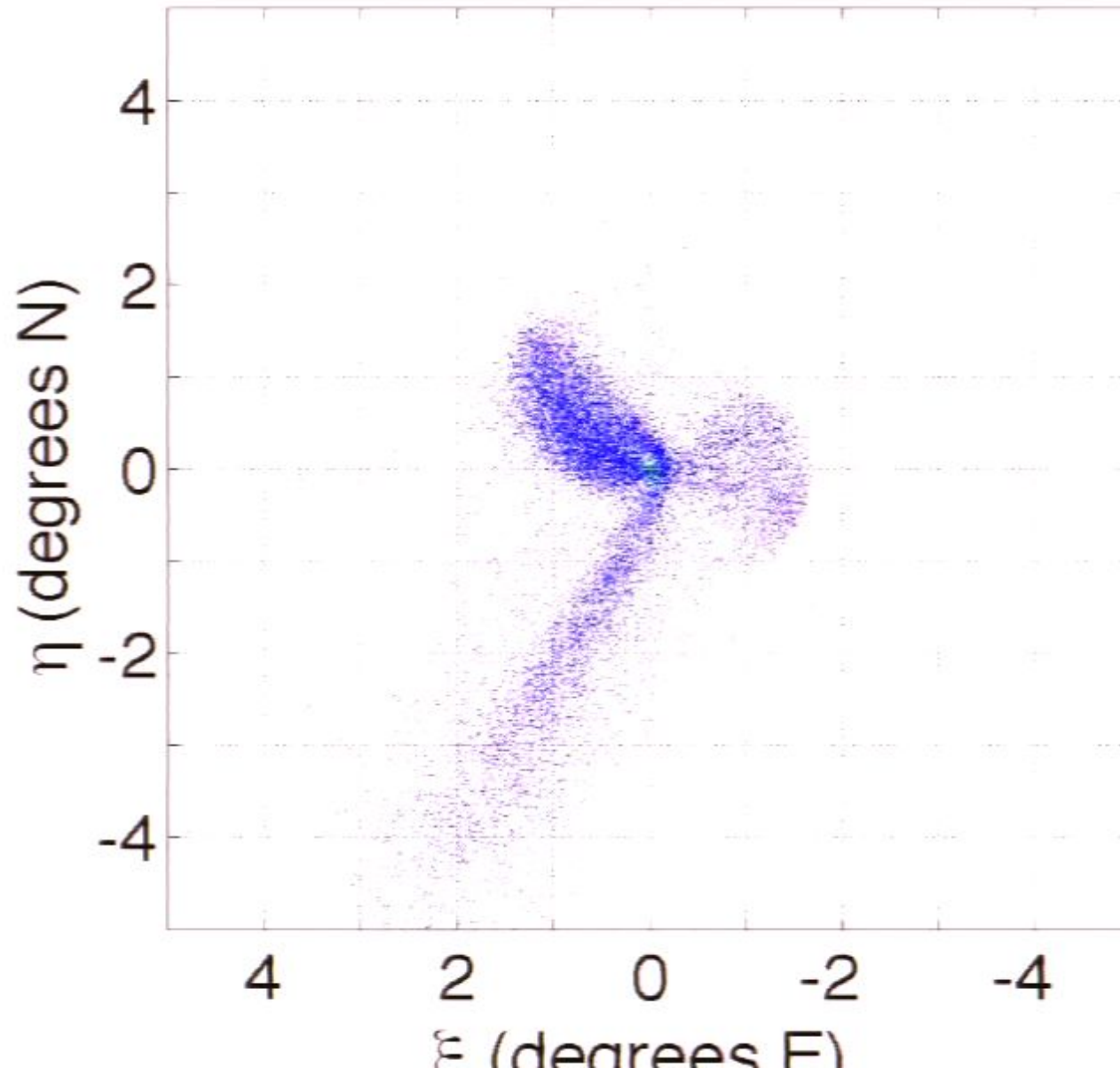
# Movie of merger in plane of sky

657.7 Myr



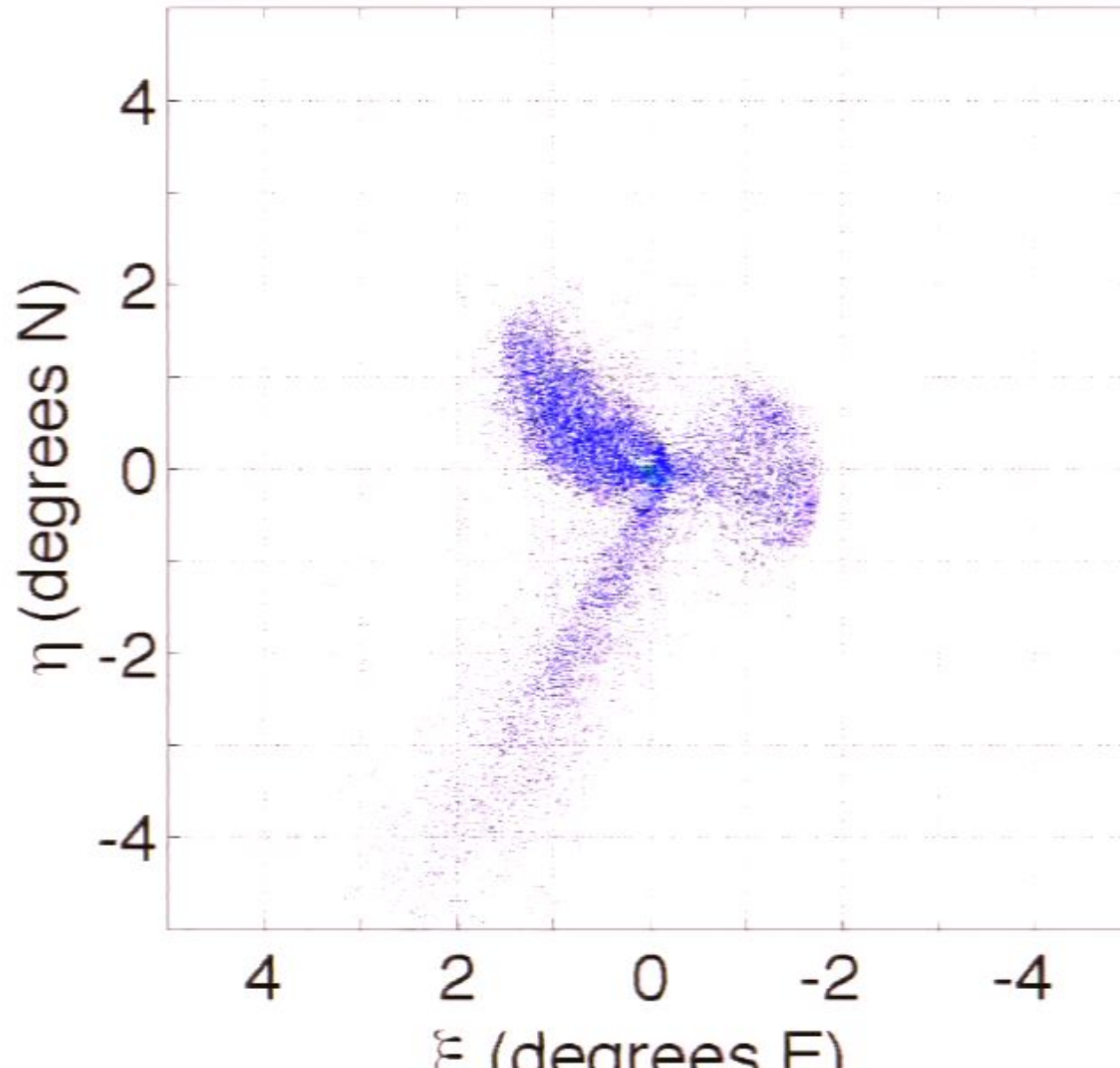
# Movie of merger in plane of sky

780.7 Myr



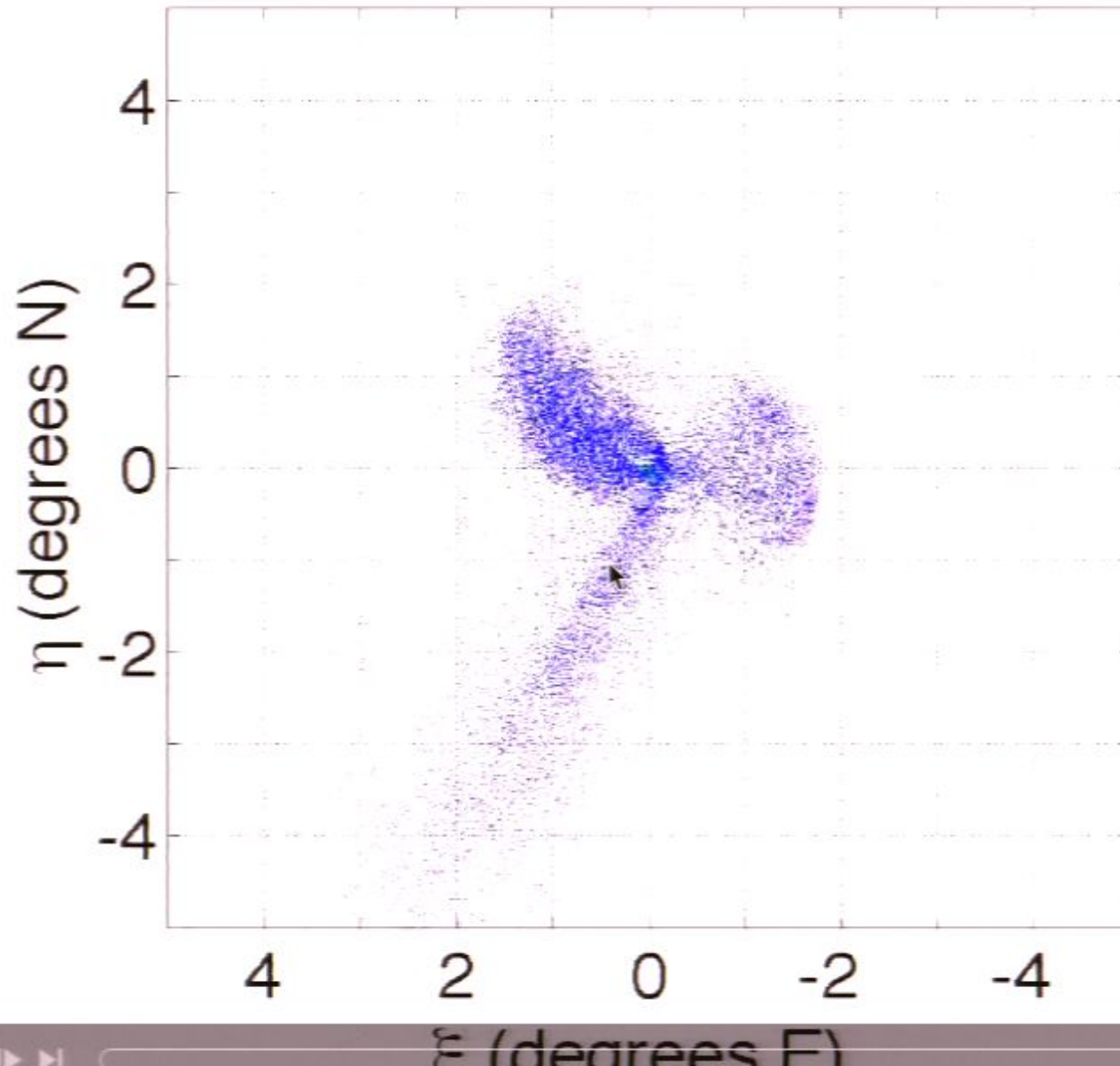
# Movie of merger in plane of sky

837.1 Myr



# Movie of merger in plane of sky

837.1 Myr



# 3D realization of final structure

Playlist

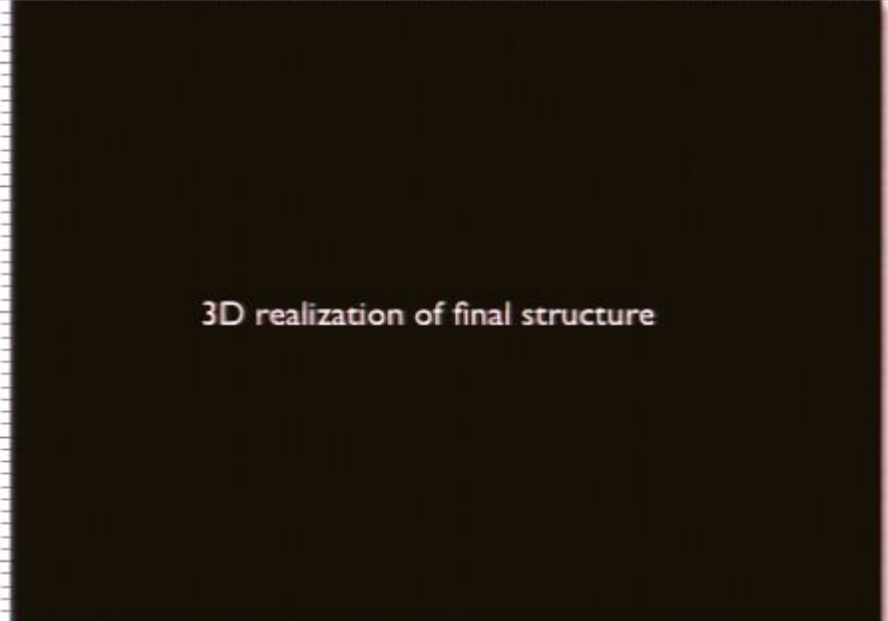
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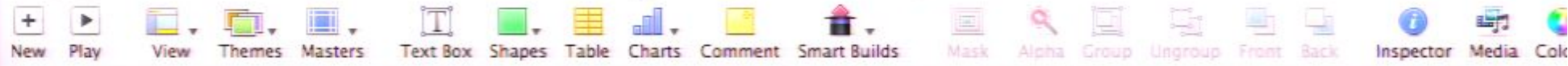
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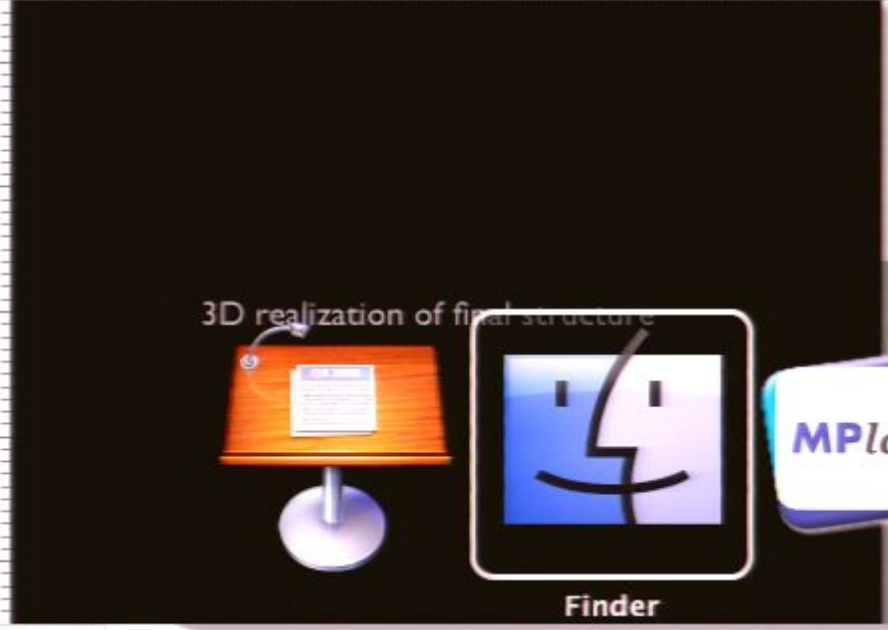
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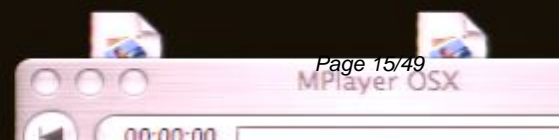
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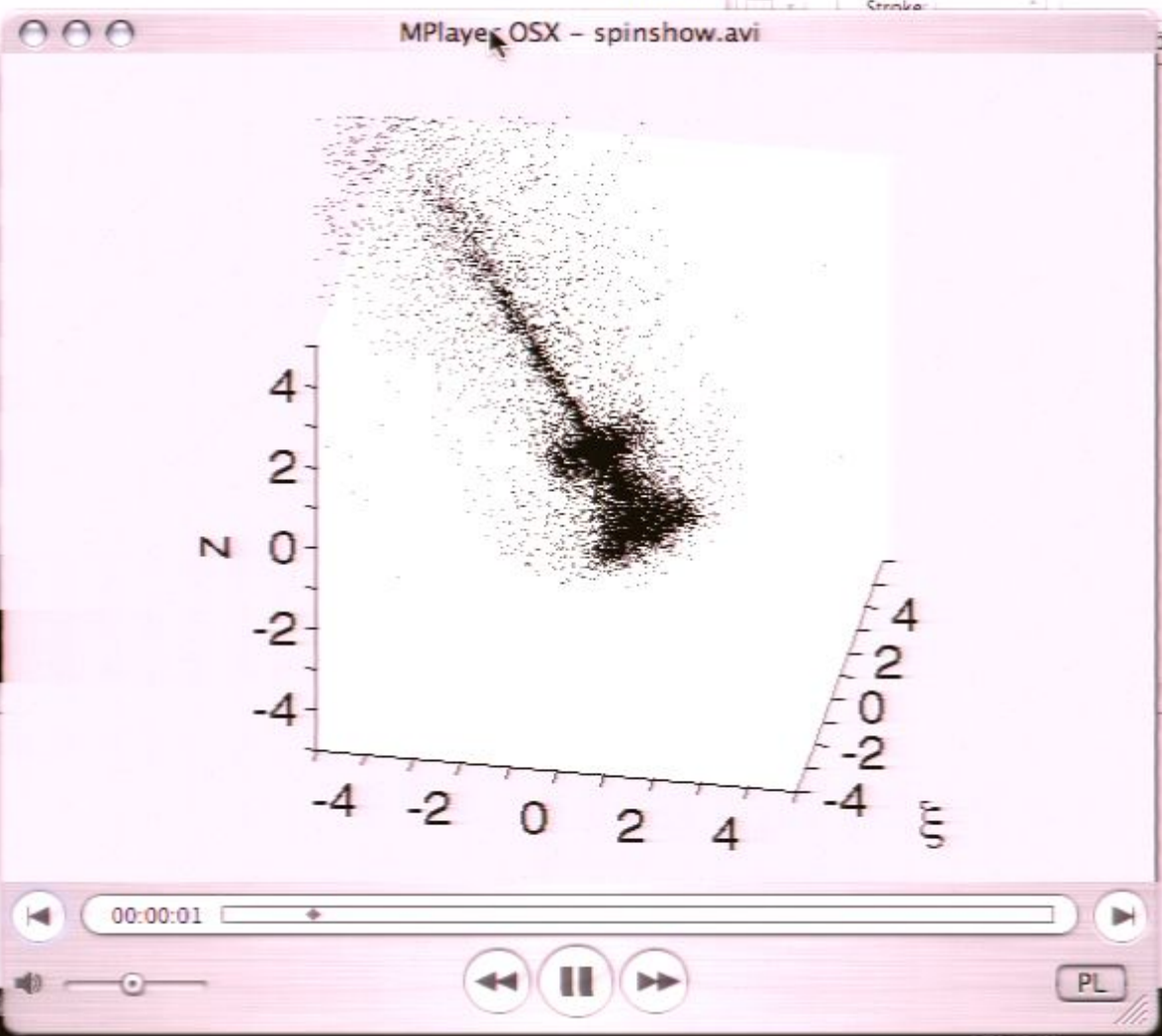
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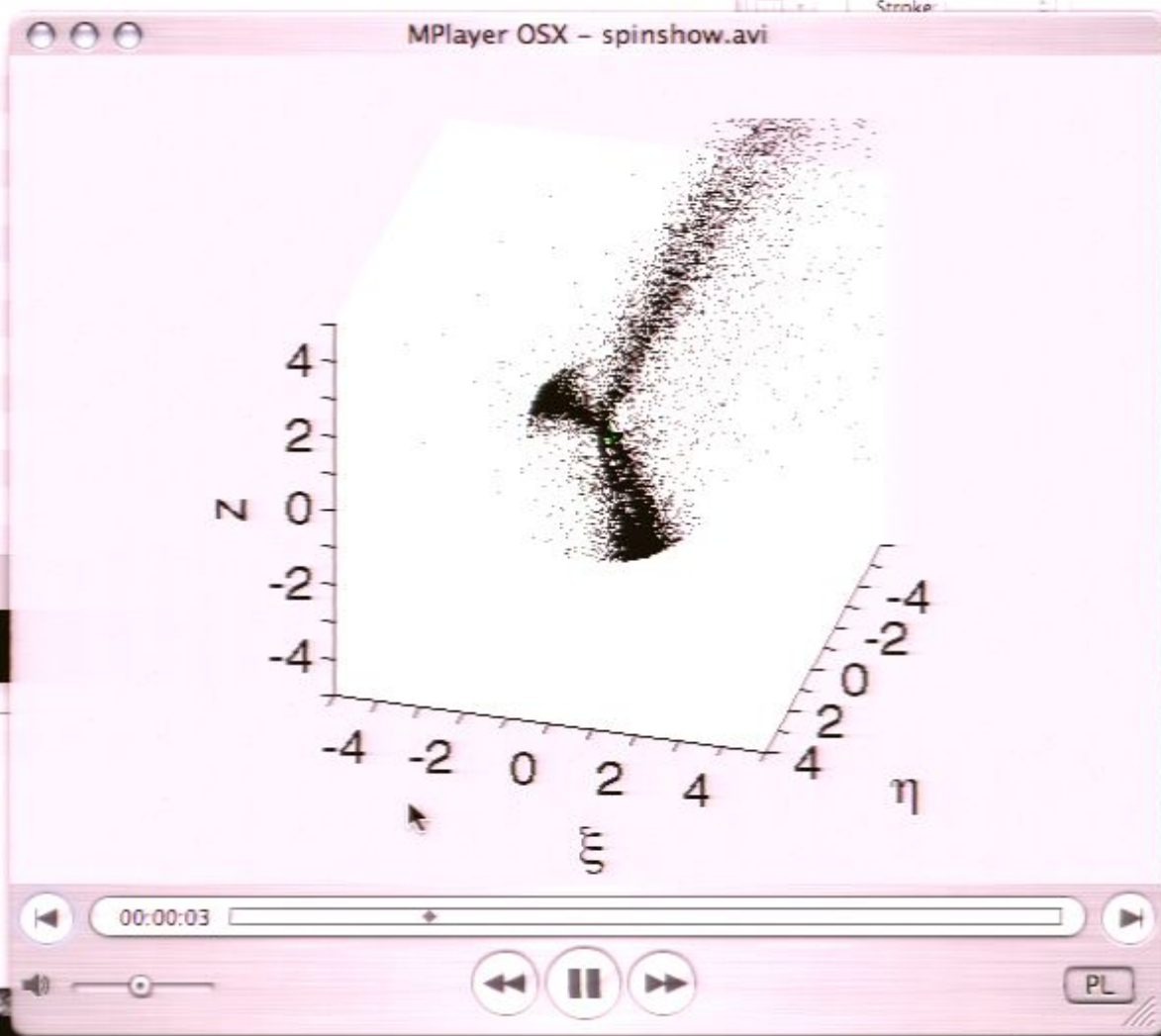
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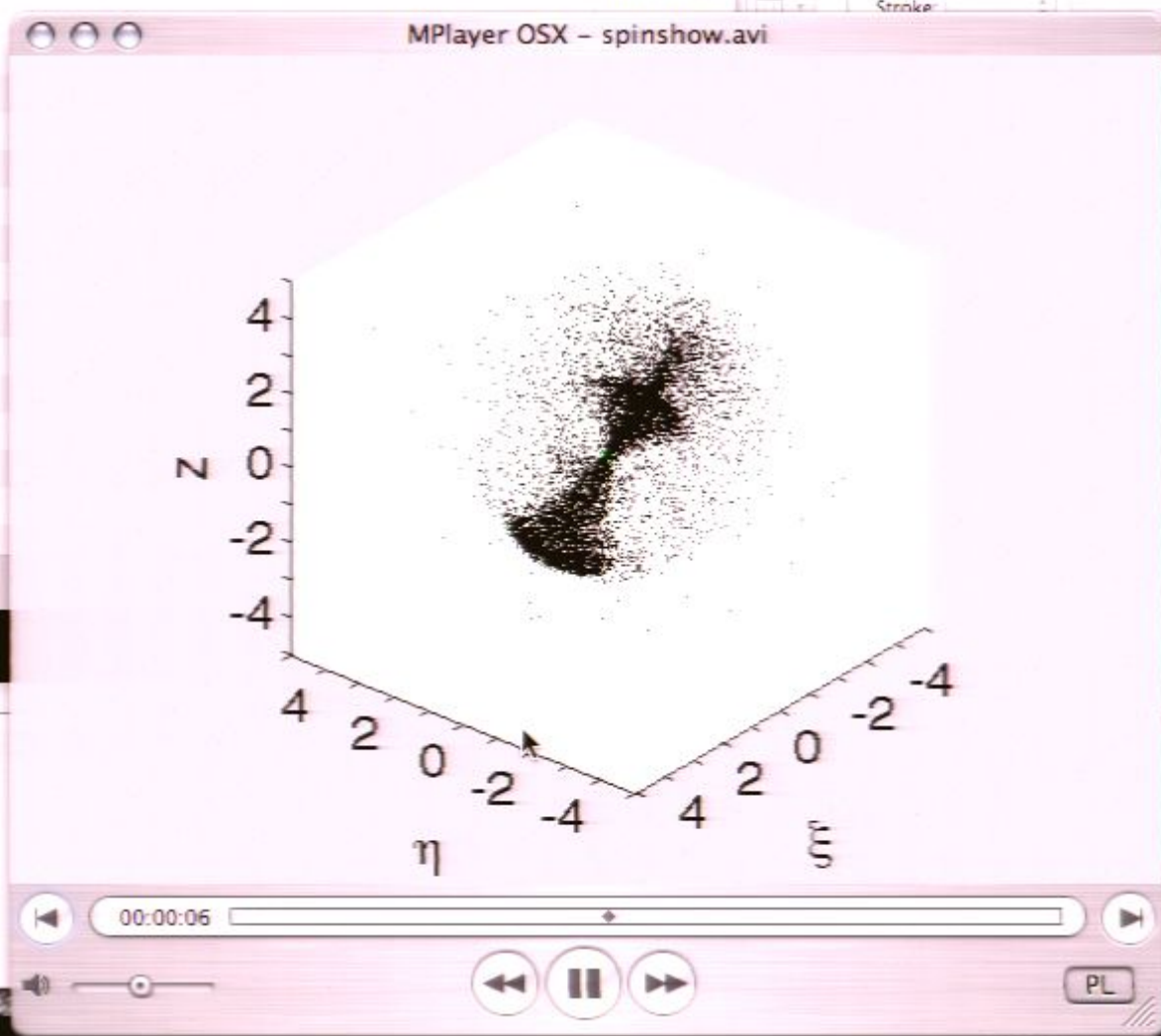
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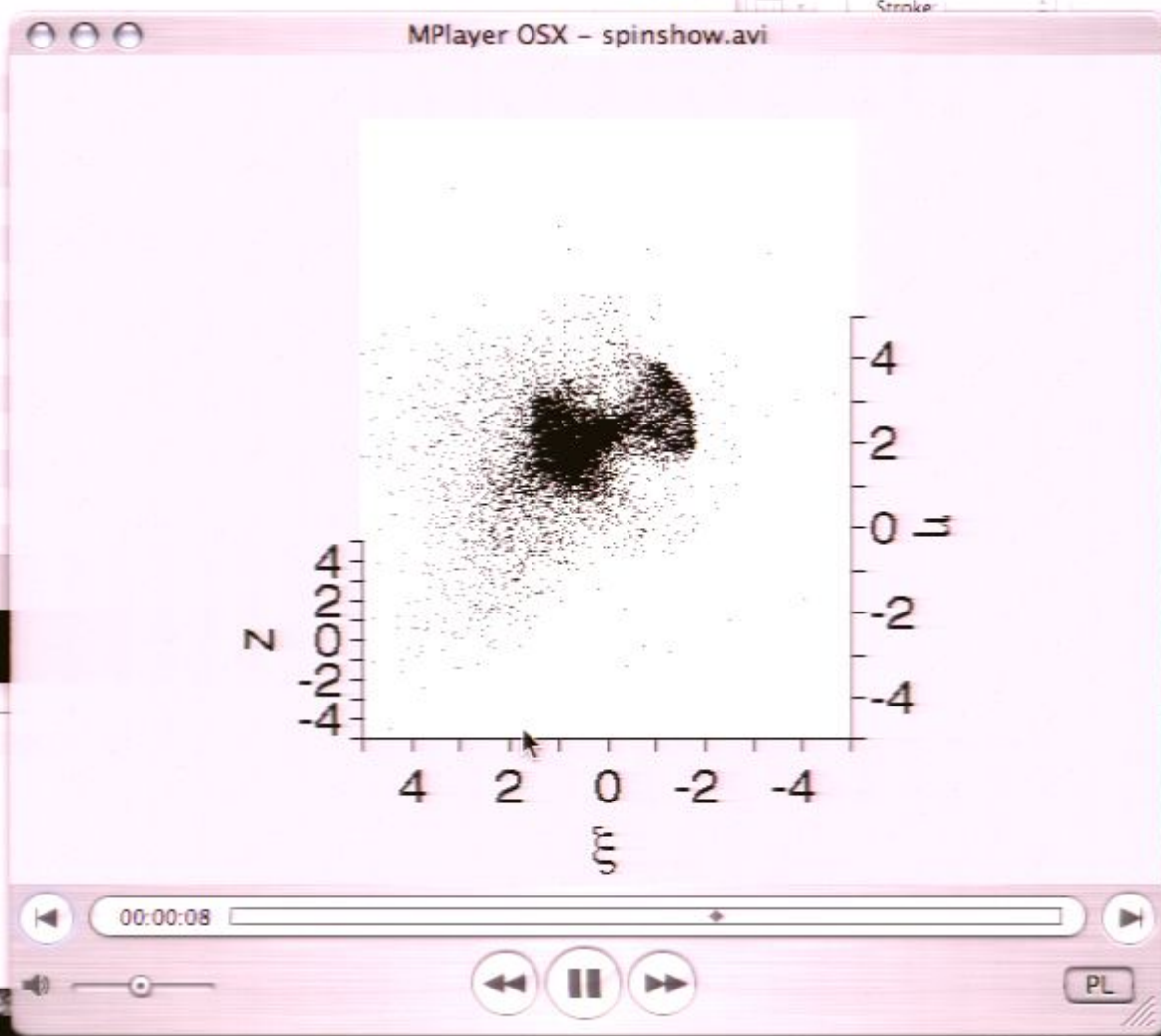
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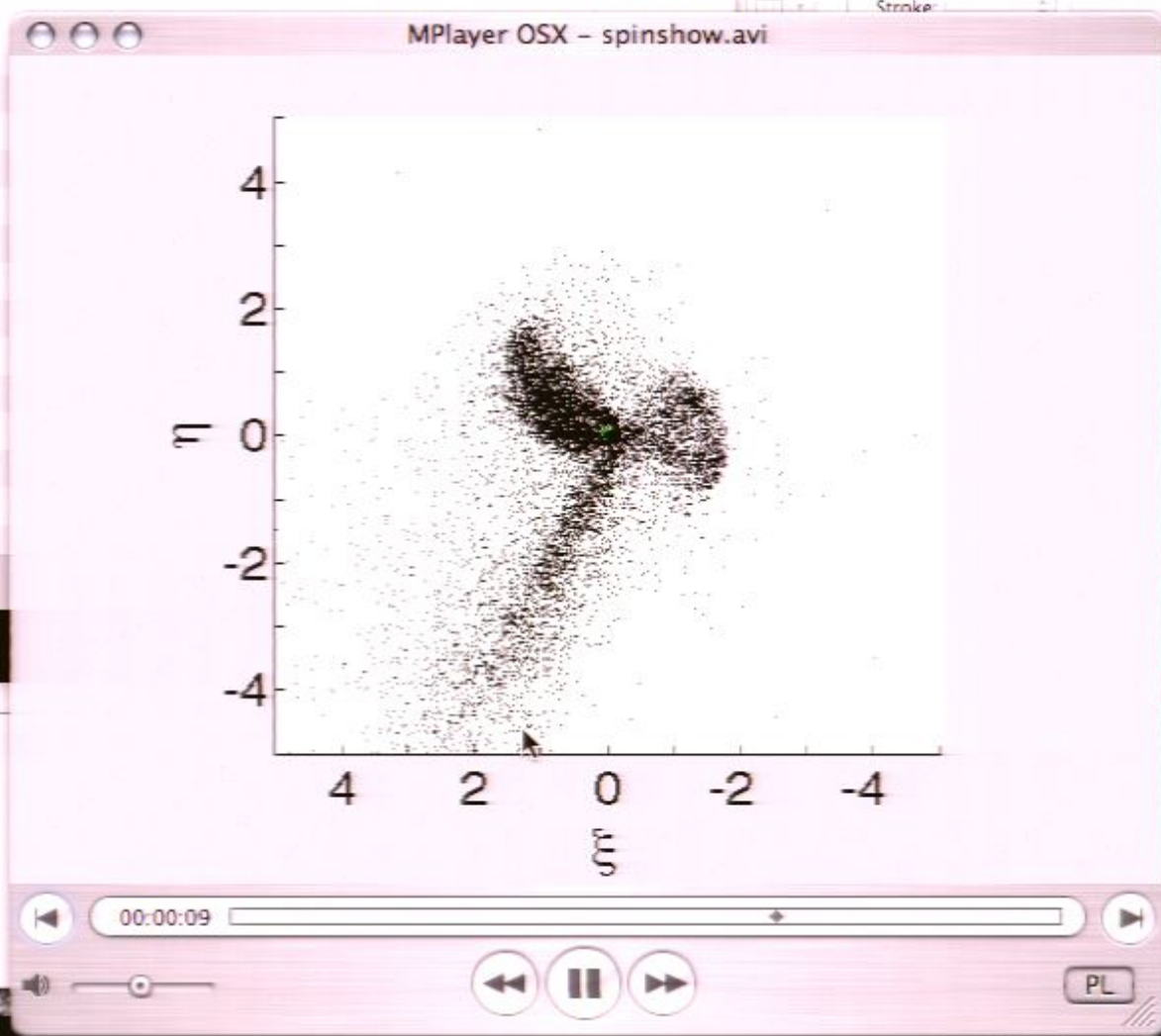
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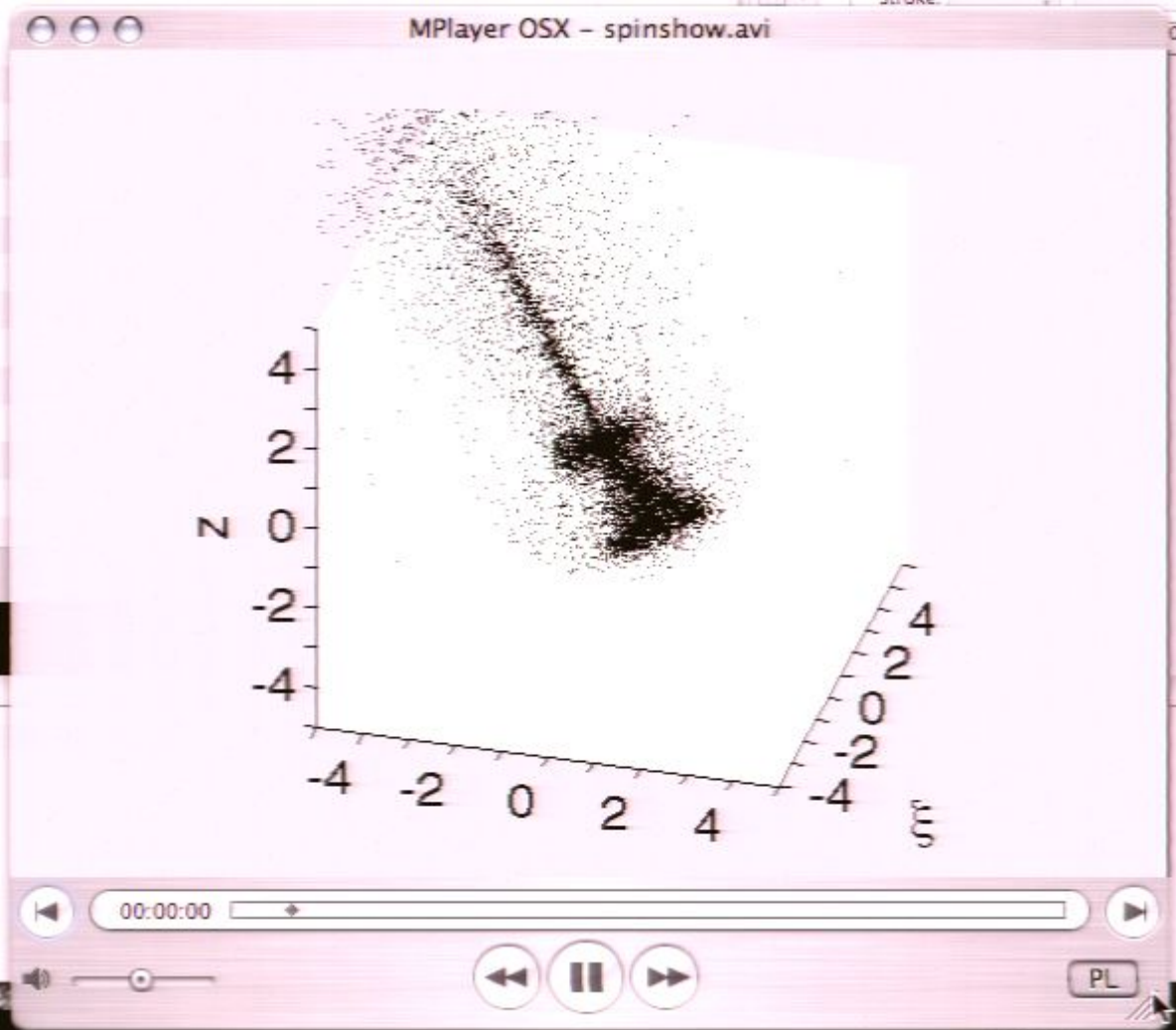
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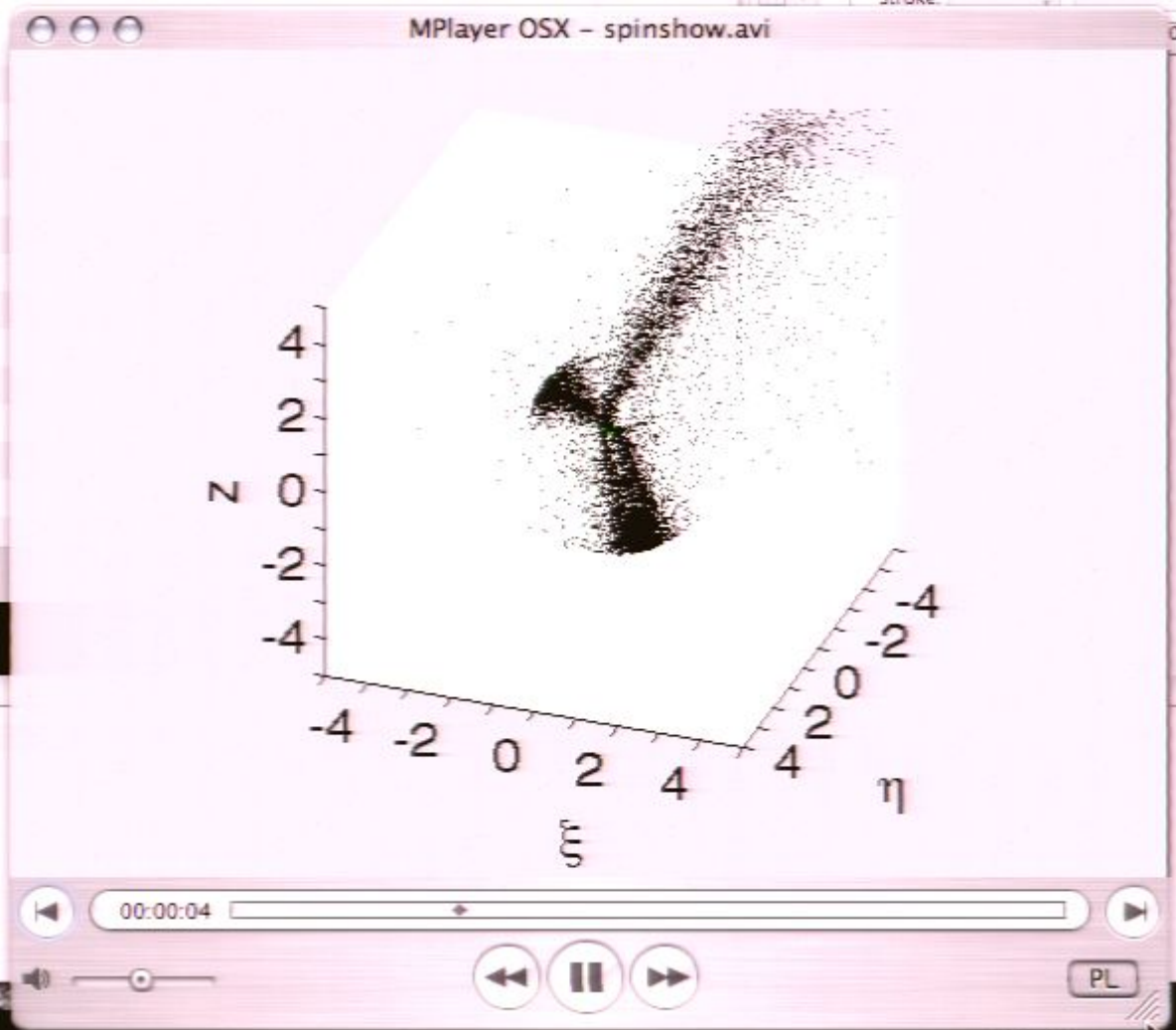
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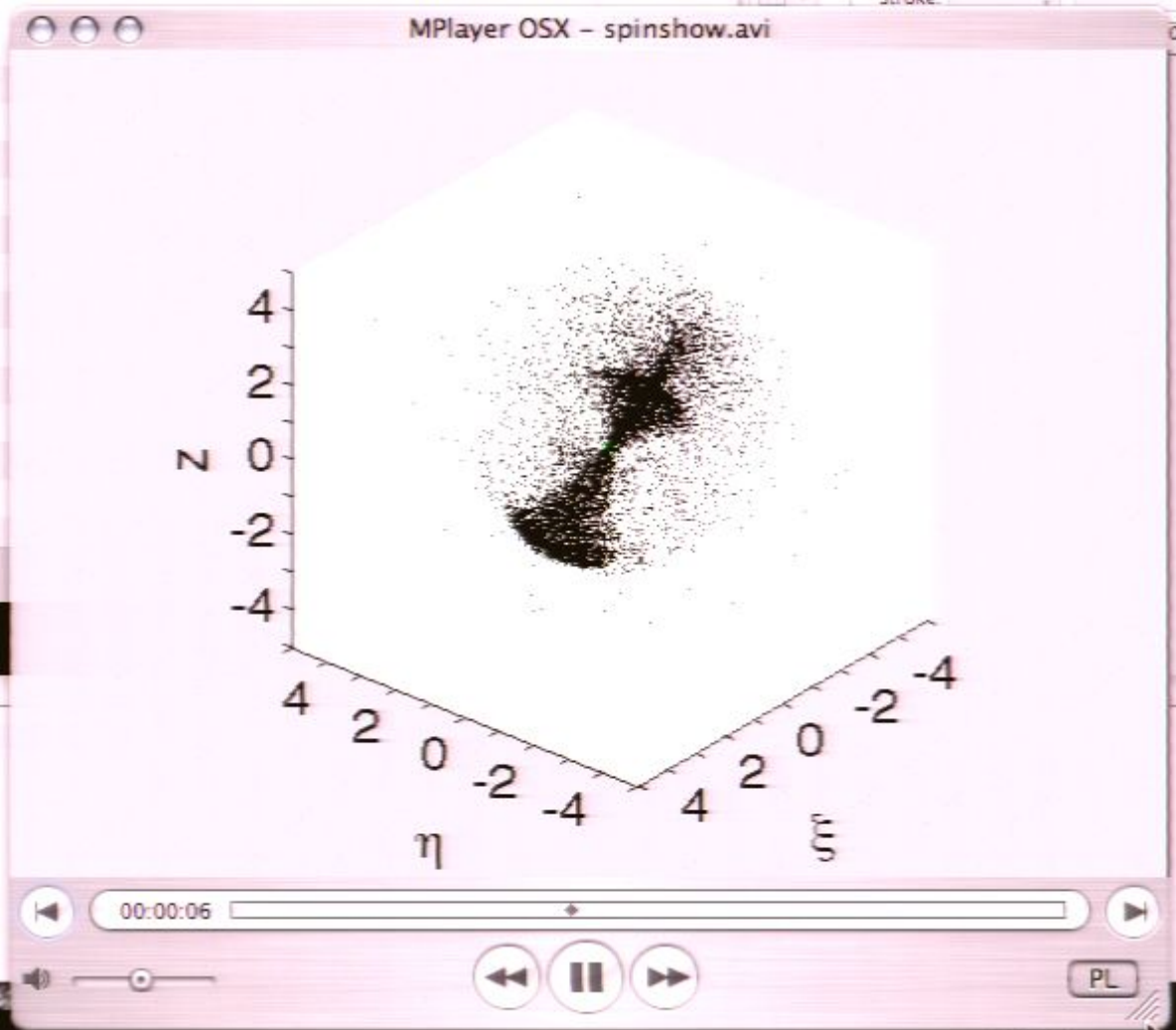
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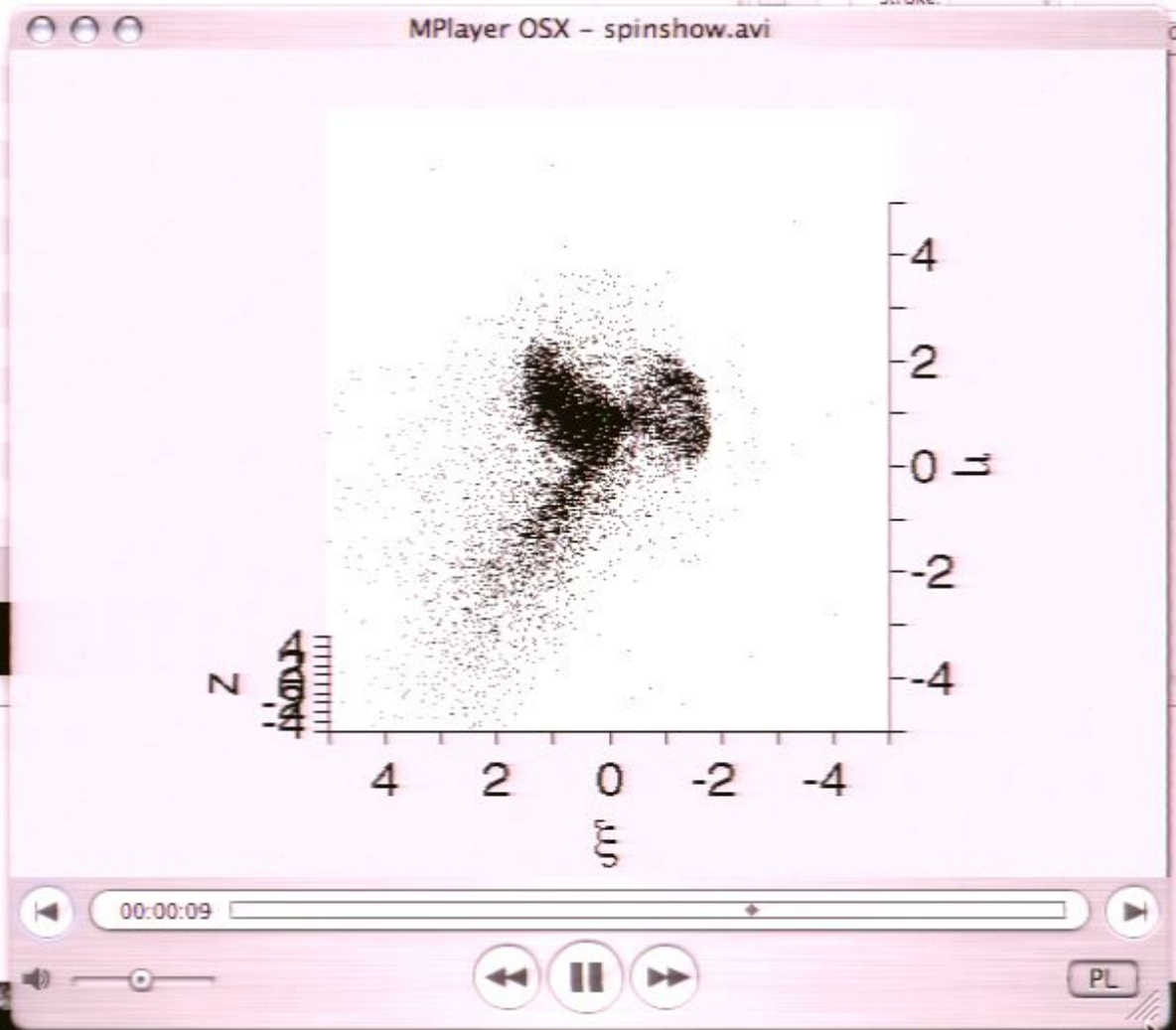
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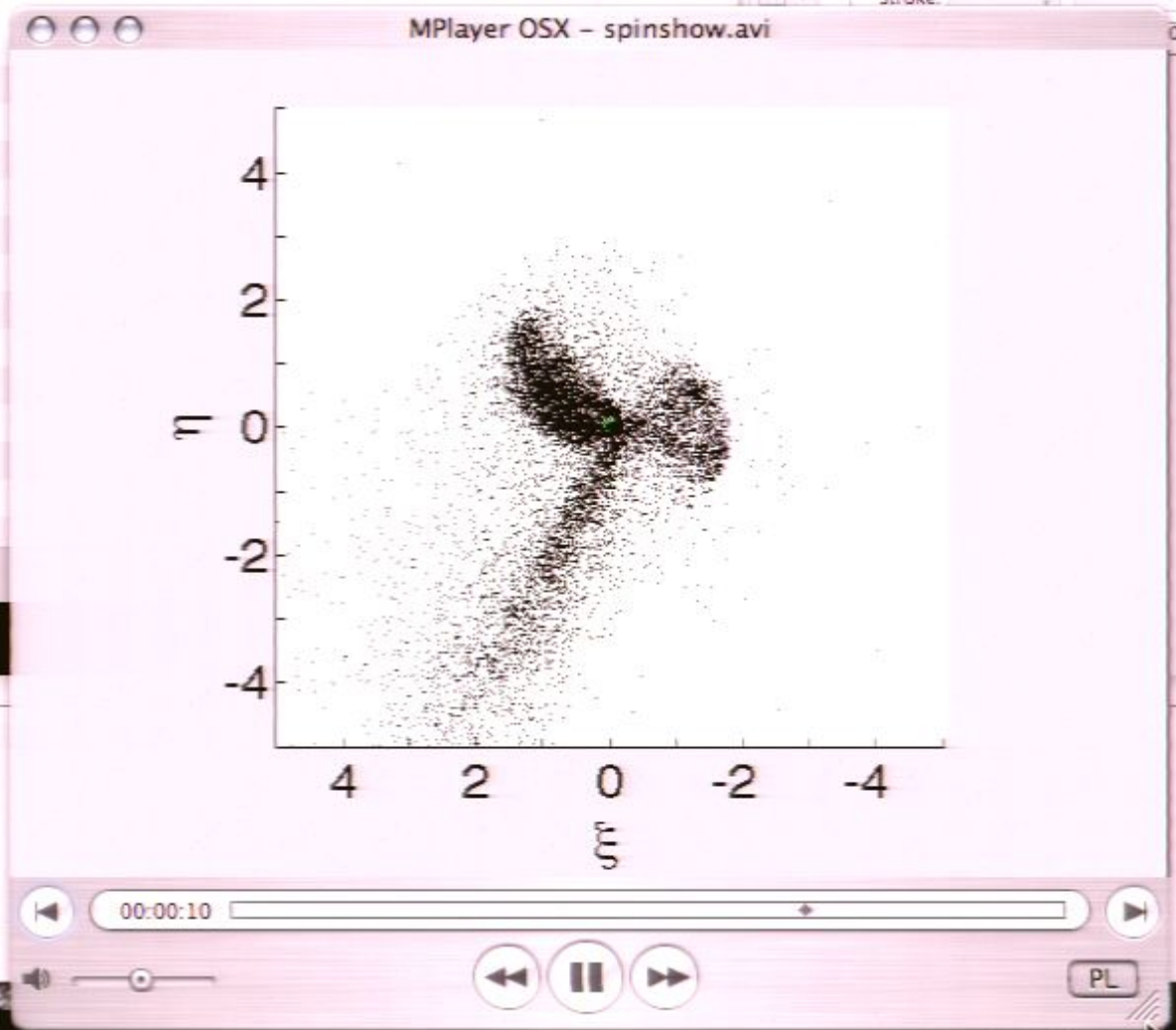
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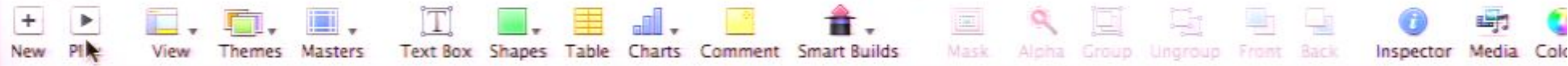
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# 3D realization of final structure

$$\Phi_{\gamma} = \Phi_{SUSY} \Phi_{\text{cosmo}}$$

$$\Phi_{SUSY} = \frac{1}{4\pi} \frac{\langle \sigma v \rangle}{m_{\chi}^2} Q_{\gamma}$$

$$\leq 4.5 \times 10^{-12} \text{ kpc}^5 M_{\odot}^{-2} \text{ m}^{-2} \text{ yr}^{-1} \text{ sr}^{-1}$$

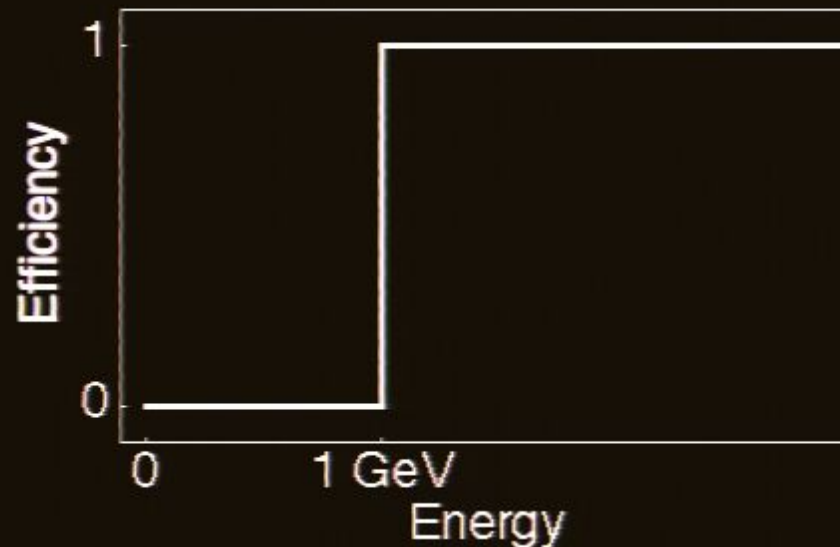
$$\Phi_{\text{cosmo}} = \frac{1}{d^2} \int \rho^2 dV$$

$$\rho^2 = \rho_{\text{halo}}^2 + 2\rho_{\text{halo}}\rho_{\text{shell}} + \rho_{\text{shell}}^2$$



# A “Gamma Ray Telescope”\*

- Spatial resolution at 10 GeV:  $0.1^\circ$
- Field of view: 2 sr
- Effective area:  $1 \text{ m}^2$ , independent of energy
- Efficiency:



\*any resemblance to real gamma-ray telescopes, living or dead, is purely intentional

$$\Phi_\gamma = \Phi_{SUSY} \Phi_{\text{cosmo}}$$

$$\Phi_{SUSY} = \frac{1}{4\pi} \frac{\langle \sigma v \rangle}{m_\chi^2} Q_\gamma$$

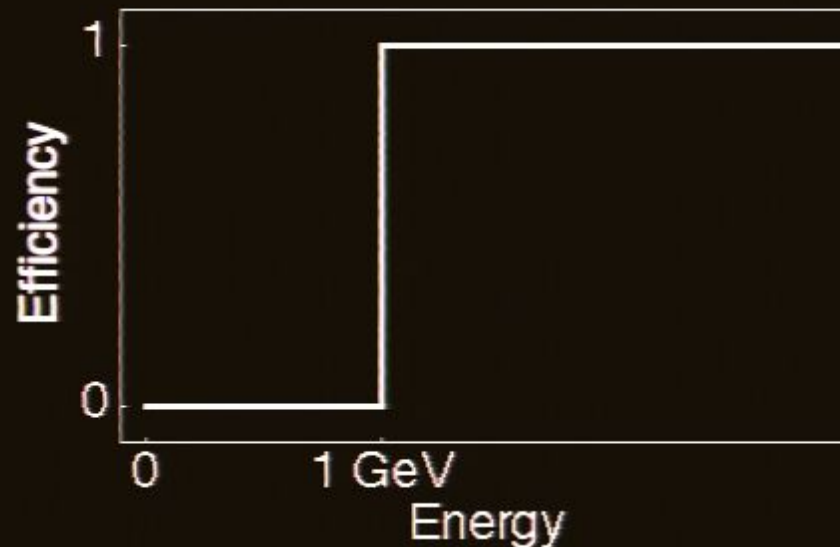
$$\leq 4.5 \times 10^{-12} \text{ kpc}^5 M_\odot^{-2} \text{ m}^{-2} \text{ yr}^{-1} \text{ sr}^{-1}$$

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# A “Gamma Ray Telescope”\*

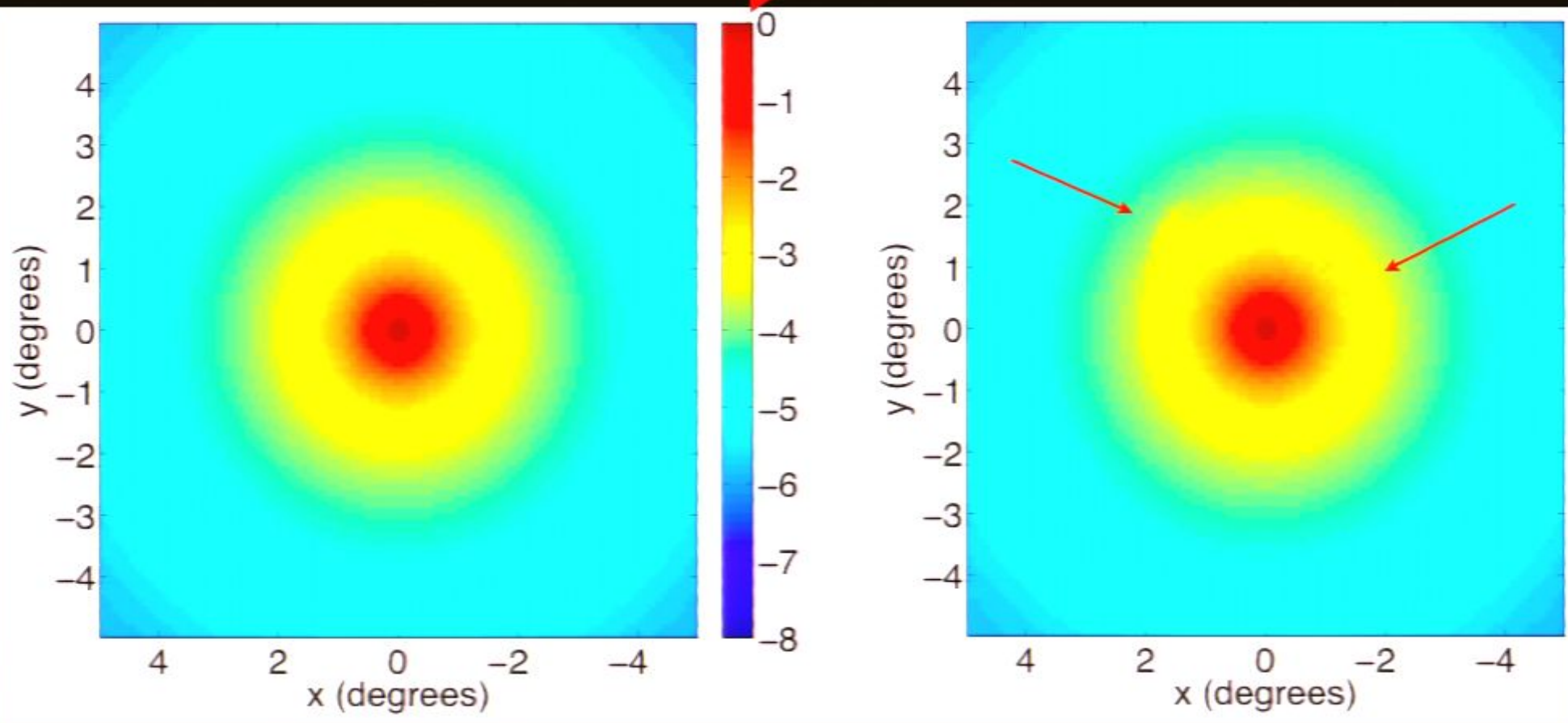
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- Effective area:  $1 \text{ m}^2$ , independent of energy
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\*any resemblance to real gamma-ray telescopes, living or dead, is purely intentional

Log ( $\gamma/\text{m}^2/\text{yr}/\text{pixel}$ )  
above 1 GeV

$$C_{\text{halo}} = R_{200}/r_h = 25.5$$



Flux from NFW halo  
Total flux =  $58 \text{ m}^{-2} \text{ yr}^{-1}$

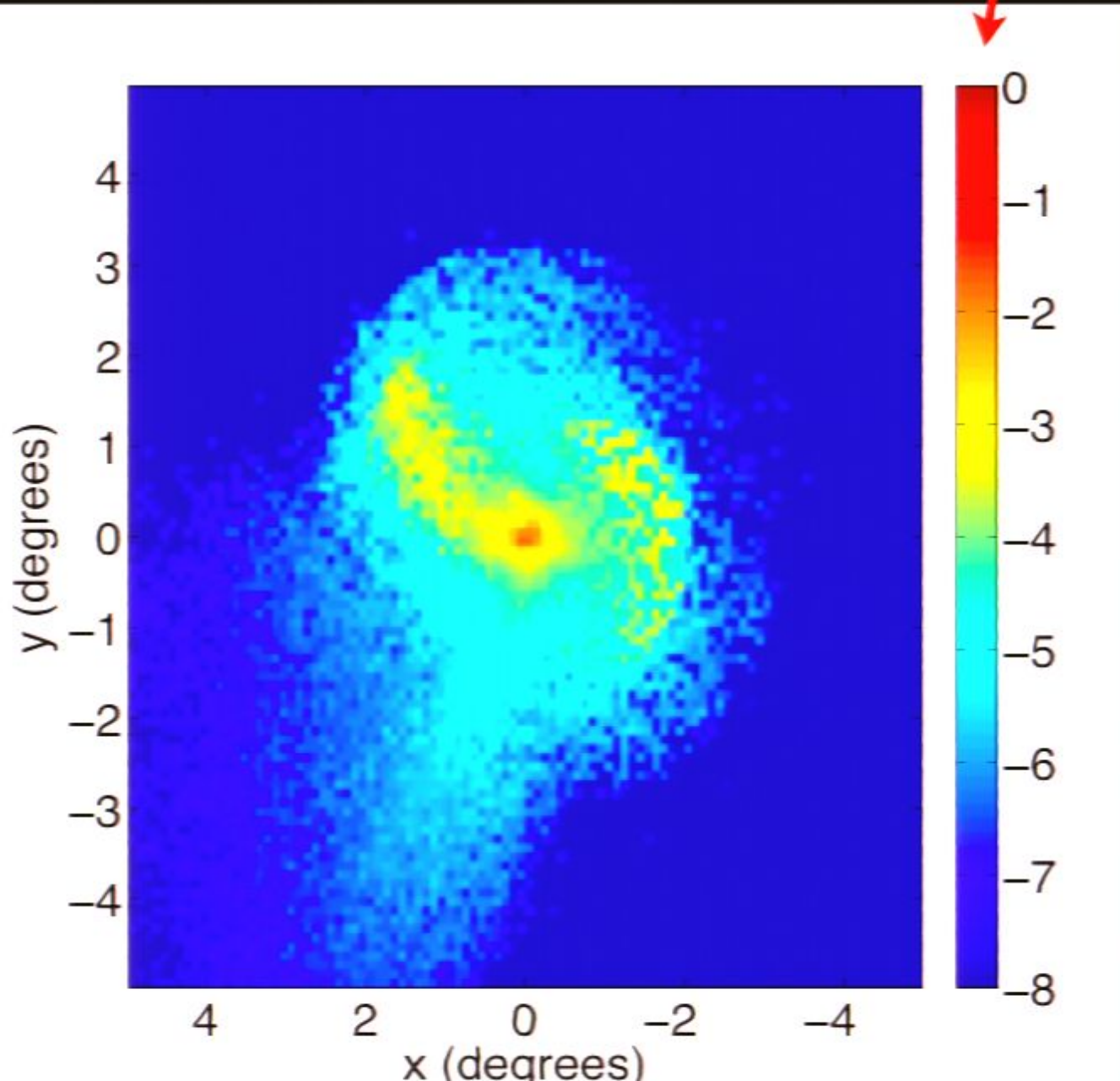
Total flux from all components  
contribution from shell: 0.4%

Flux from shell-halo and shell-shell annihilations

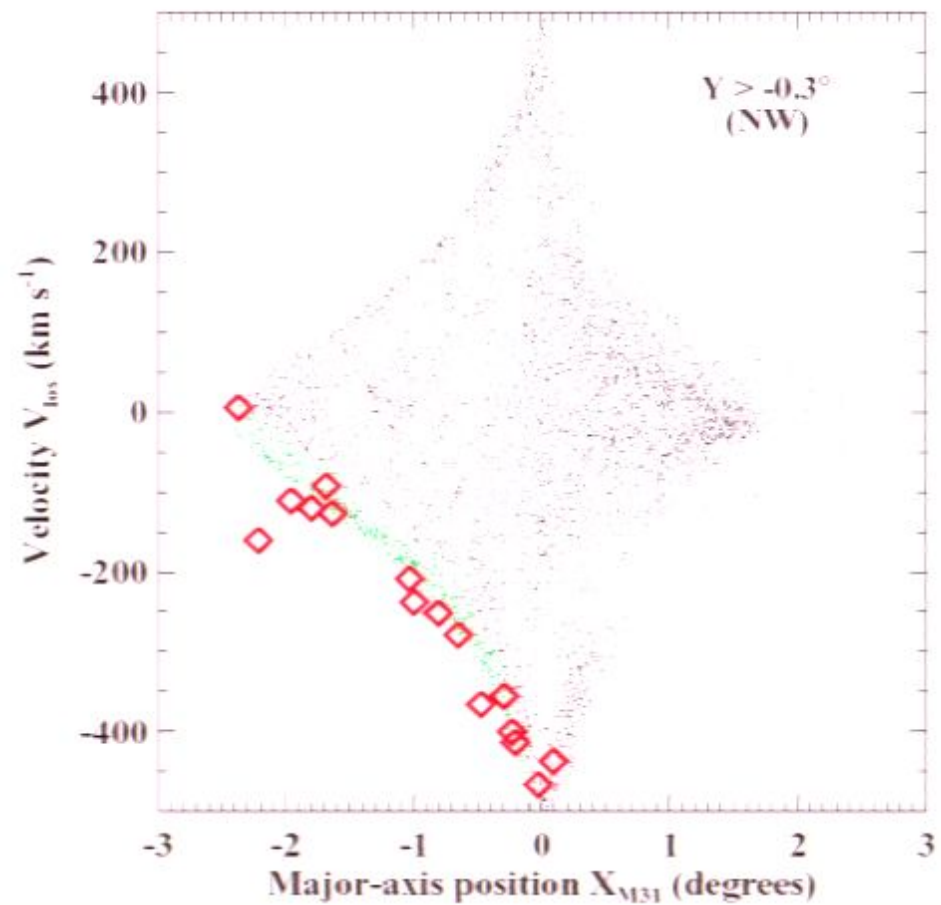
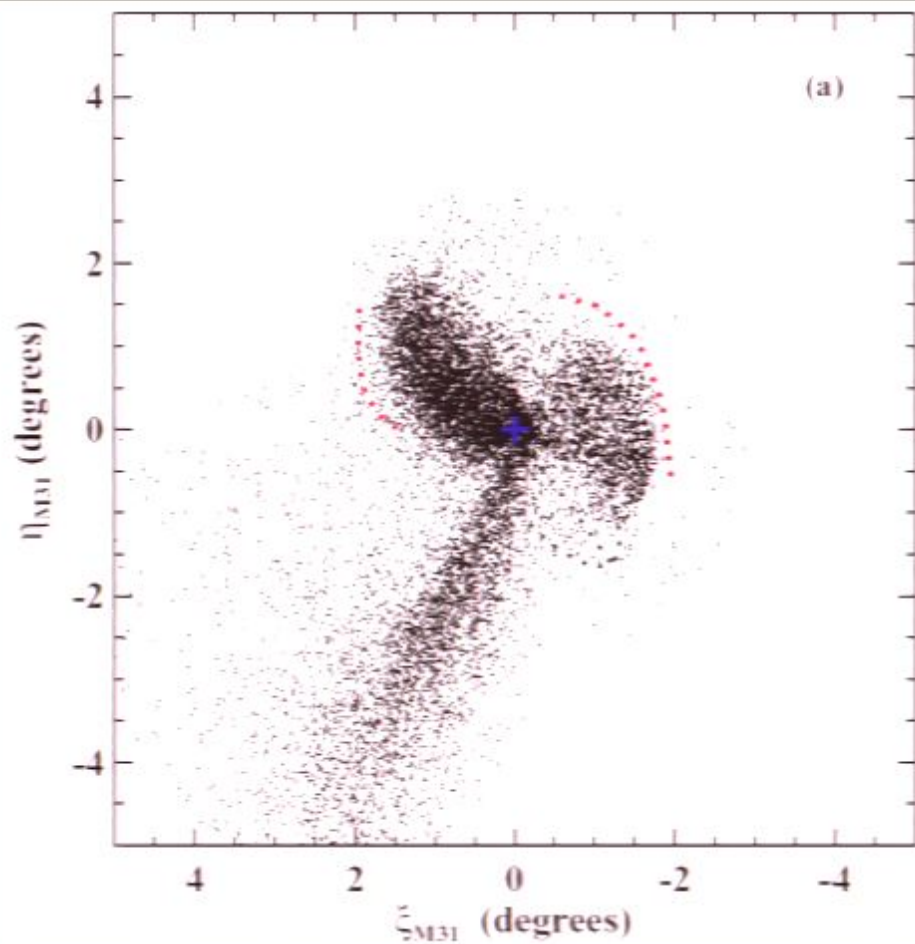
Total =  $0.25 \text{ m}^{-2} \text{ yr}^{-1}$

Log ( $\gamma/\text{m}^2/\text{yr}/\text{pixe}$   
above 1 GeV

N=200 000  
1 pixel =  $(0.1^\circ)^2$

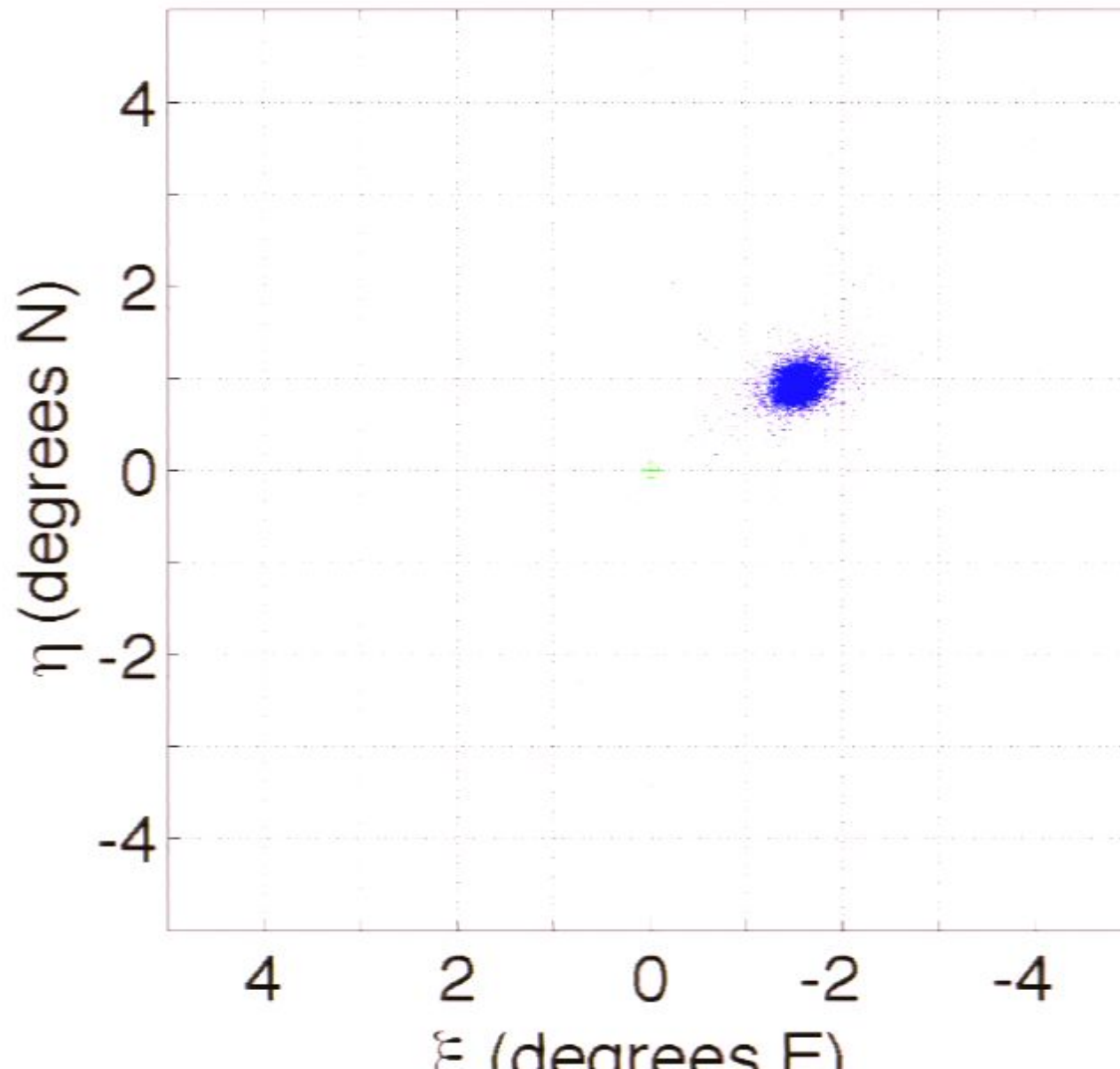


# 3D realization of final structure



# Movie of merger in plane of sky

109.1 Myr

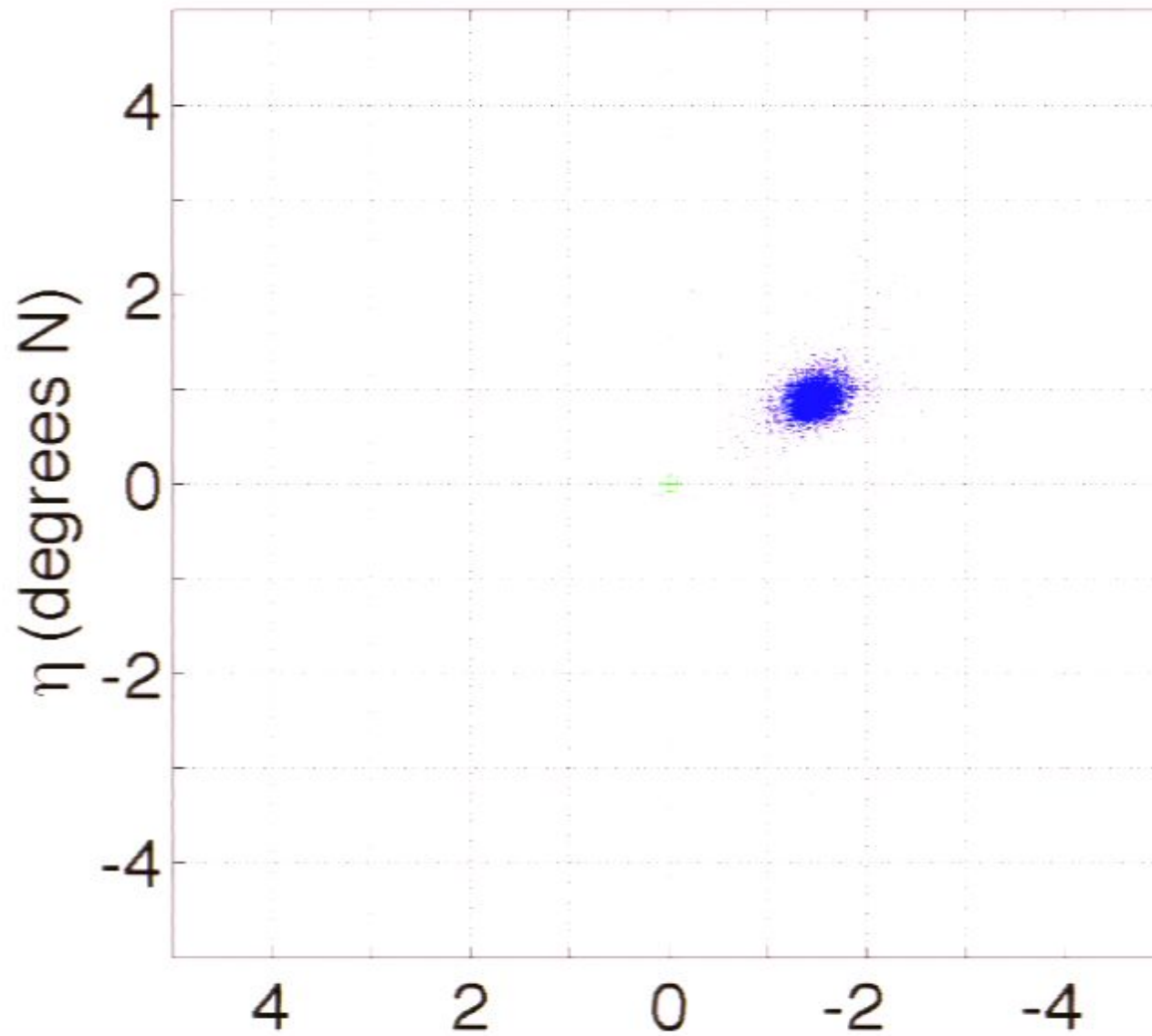




# 3D realization of final structure

# Movie of merger in plane of sky

109.1 Myr

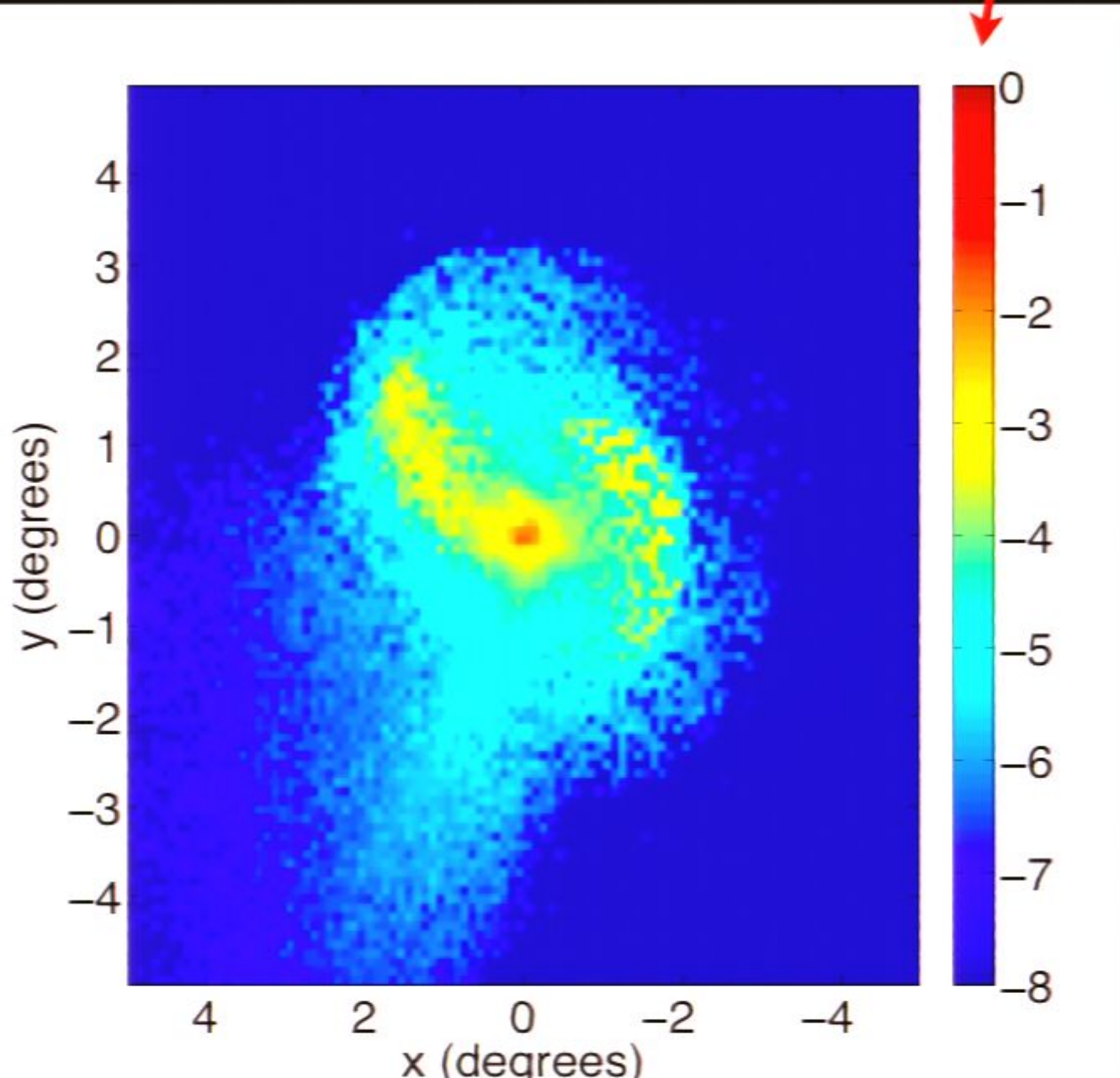


Flux from shell-halo and shell-shell annihilations

Total =  $0.25 \text{ m}^{-2} \text{ yr}^{-1}$

Log ( $\gamma/\text{m}^2/\text{yr}/\text{pixe}$   
above 1 GeV

N=200 000  
1 pixel =  $(0.1^\circ)^2$



# Approximations

- resolution (particle number)
- softened force law
- finite timesteps
- tree-based force computation
- roundoff error
- two-body interactions
- static halo
- interpolated disk potential

# To Consider

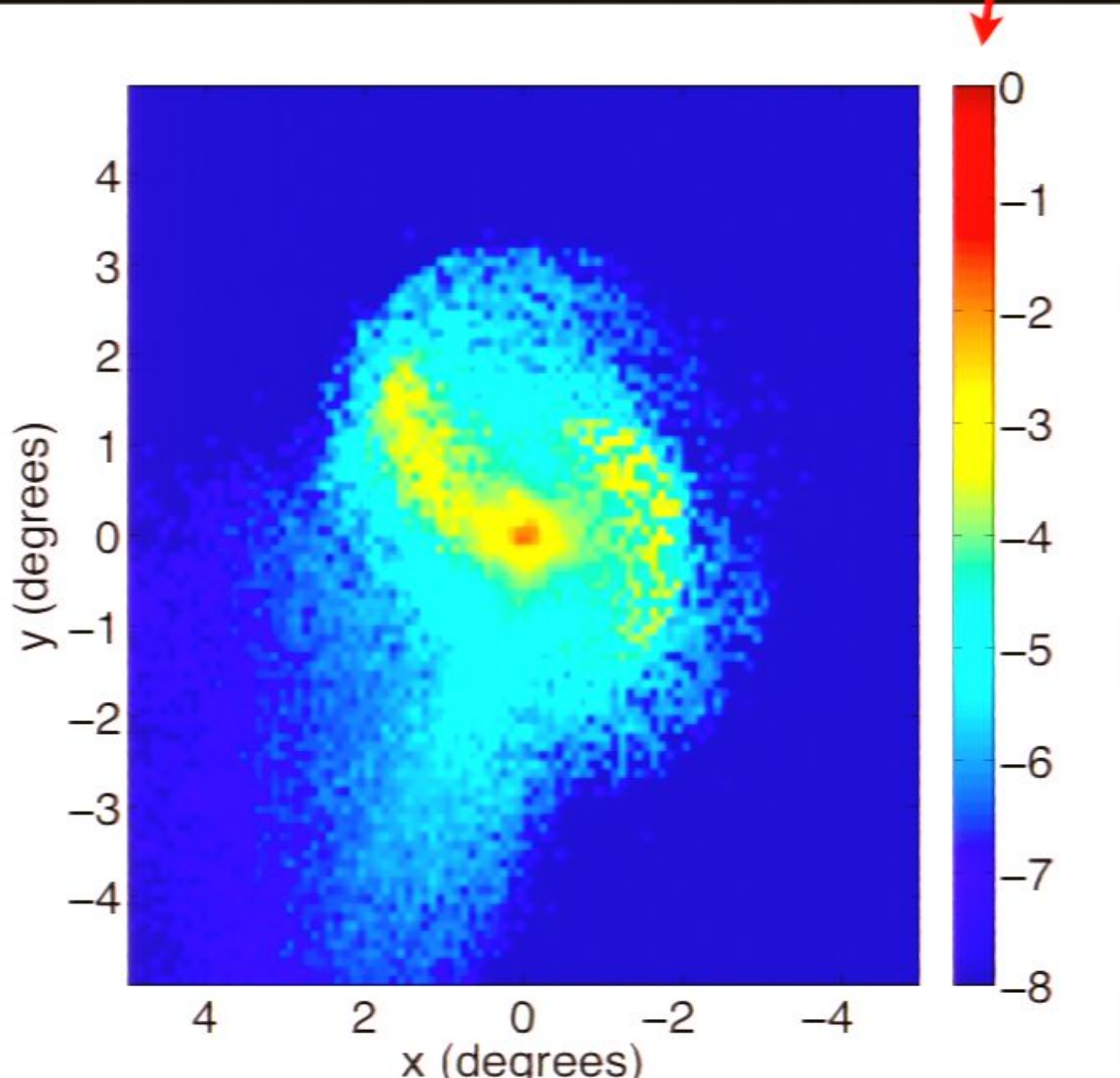
- satellite temperature
- cored vs cuspy central potential
- halo concentration
- halo substructure
- satellite substructure
- satellite spin
- dark matter fraction of satellite
- ...

# Flux from shell-halo and shell-shell annihilations

Total =  $0.25 \text{ m}^{-2} \text{ yr}^{-1}$

N=200 000  
1 pixel =  $(0.1^\circ)^2$

Log ( $\gamma/\text{m}^2/\text{yr}/\text{pixe}$   
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# Approximations

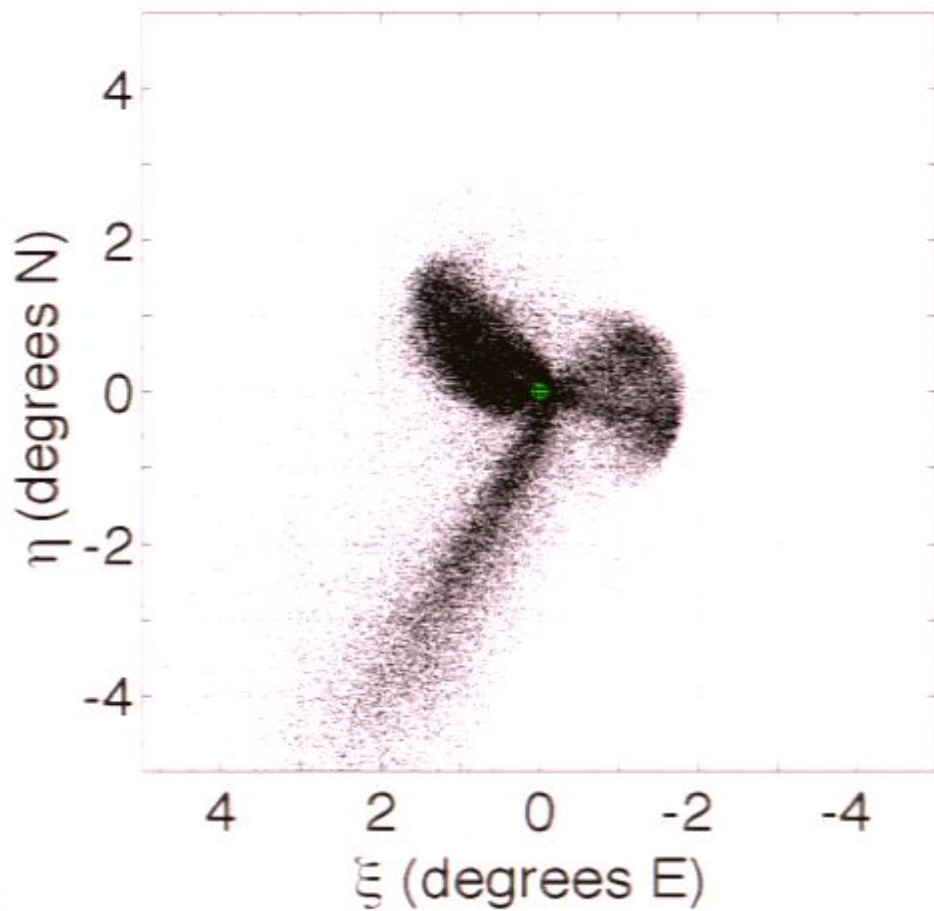
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# To Consider

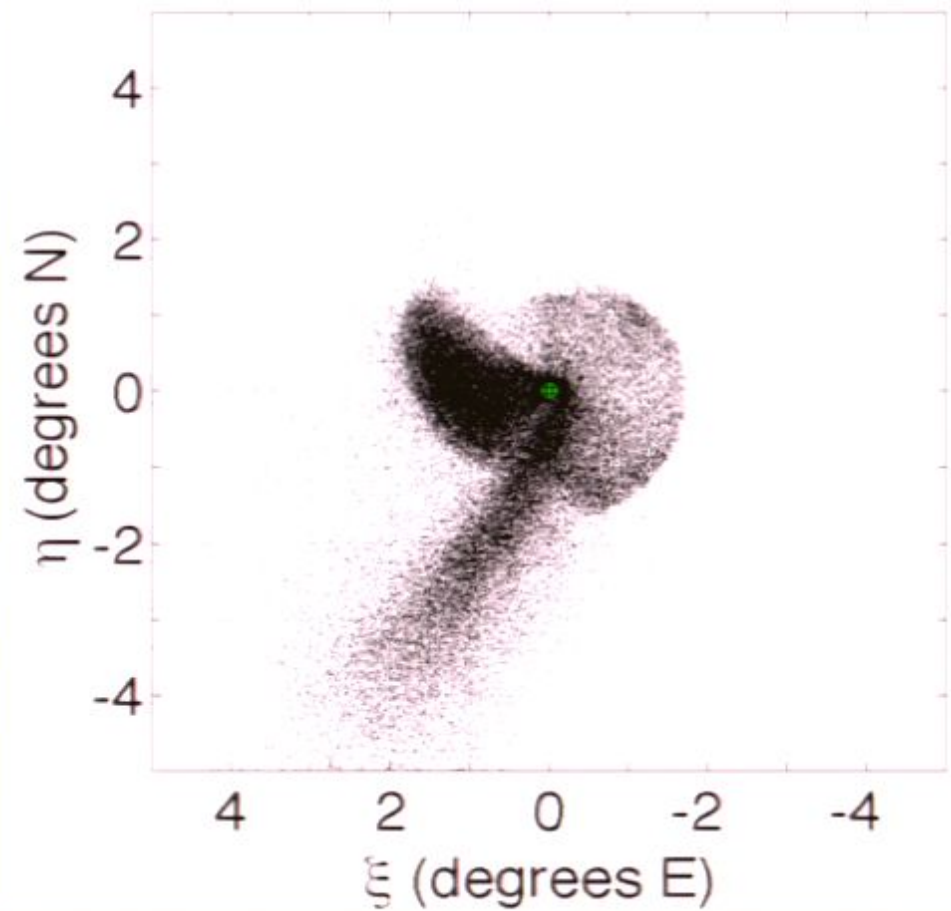
- satellite temperature
- cored vs cuspy central potential
- halo concentration
- halo substructure
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- satellite spin
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- ...

# Effect of halo concentration

Outcome with original halo

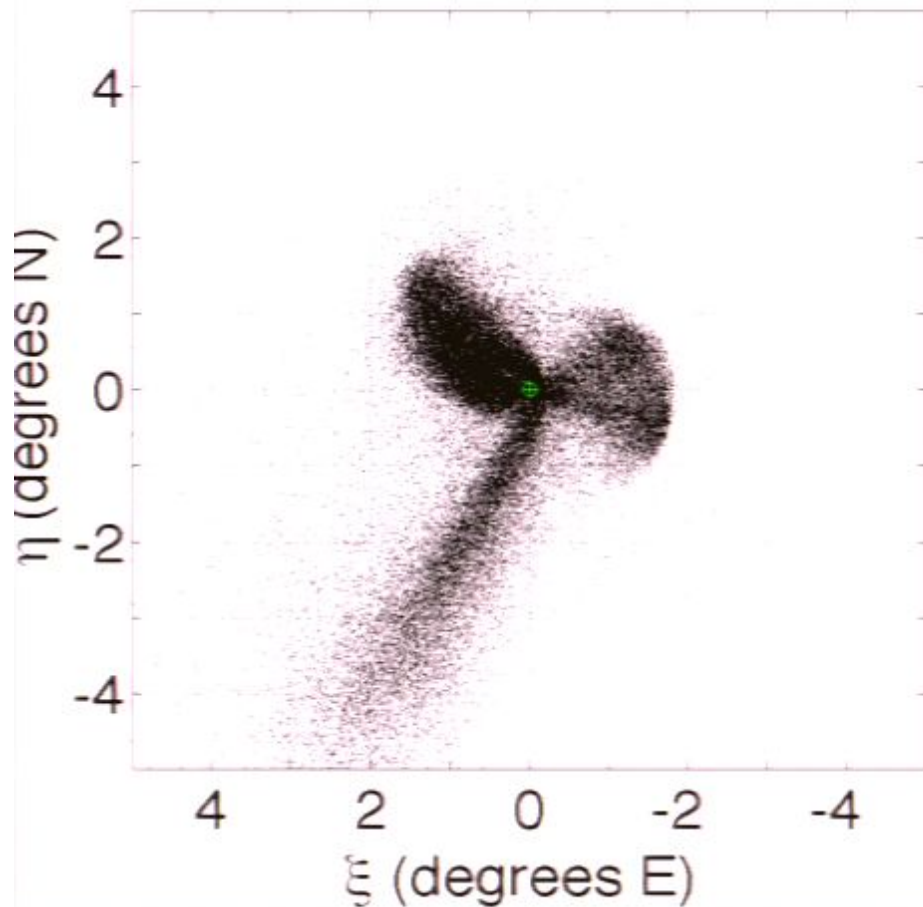


Outcome with best-fit halo

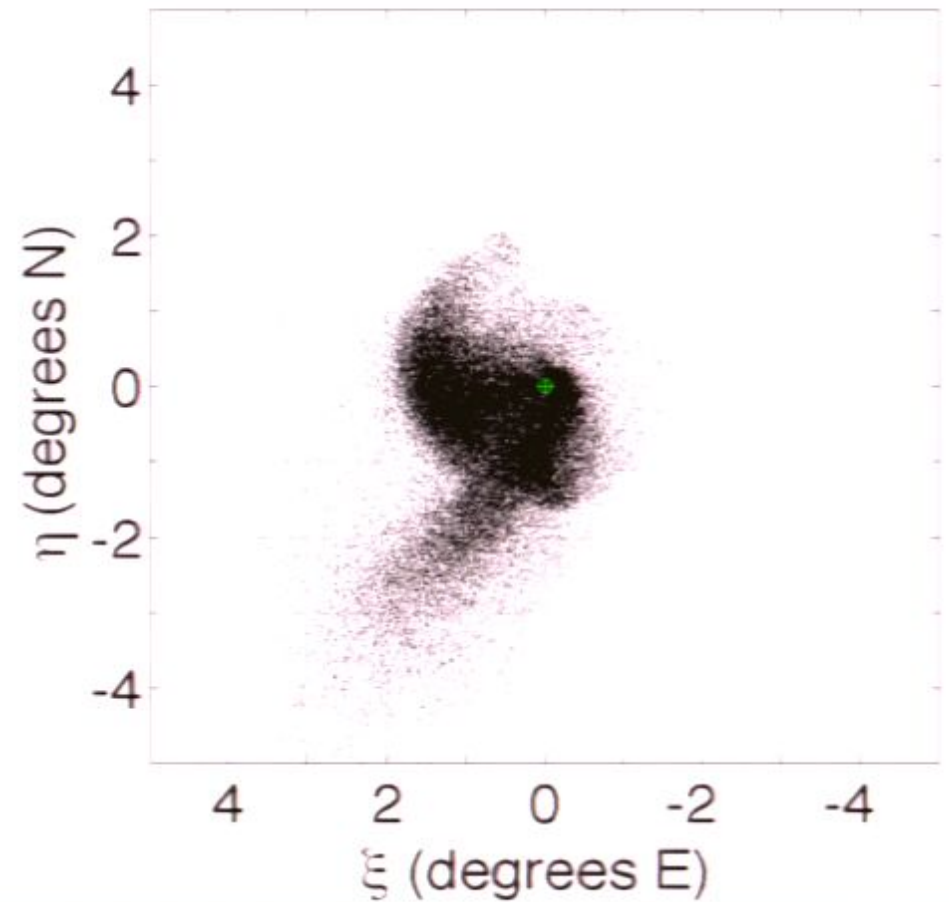


# Effect of halo concentration

Outcome with original halo



Outcome with low-concentration halo





# Conclusion

- This particular structure not observable with GLAST
- Caveat: resolution limits max density
- Milky Way is 100x closer!