Title: Magnification of High-z Galaxies

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Abstract: TBA

Magnification of high-z galaxies

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Collaborators

Marcos Lima, Mark Devlin, James Aguirre

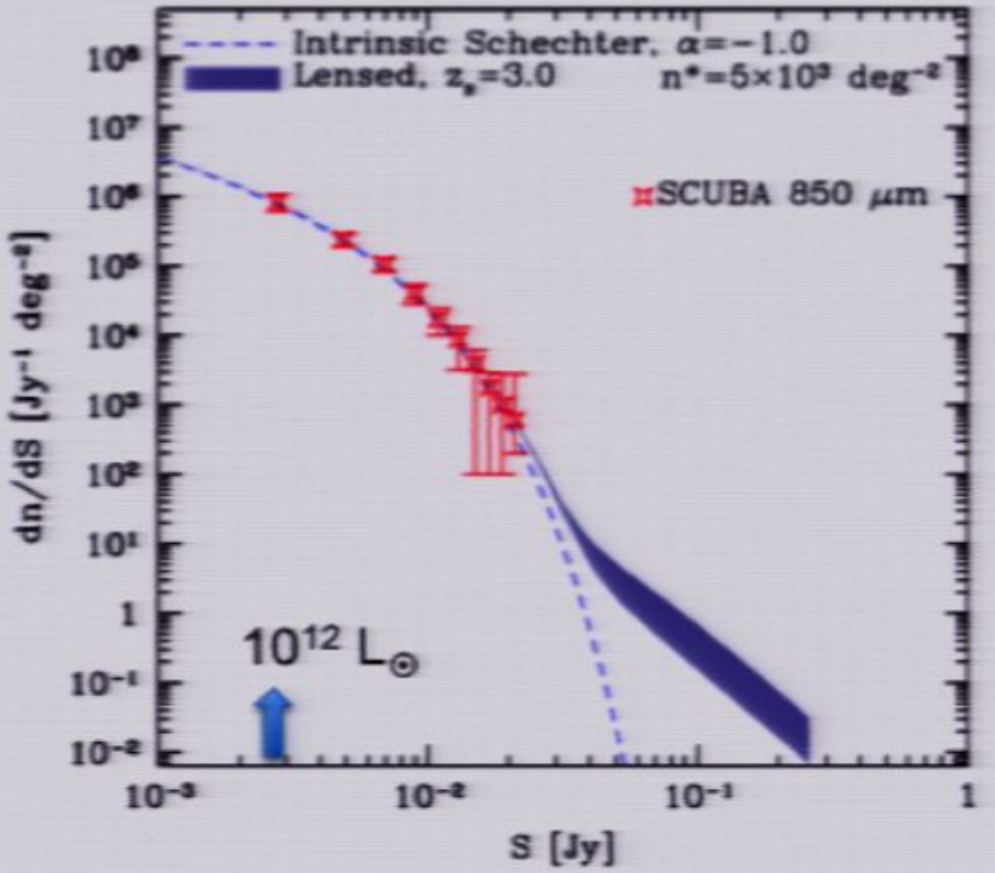
References:

Lima, Jain, Devlin & Aguirre 2010, arXiv:1004.4889

Jain & Lima 2010, arXiv:1003.6127

Lima, Jain & Devlin 2009, arXiv:0907.4387

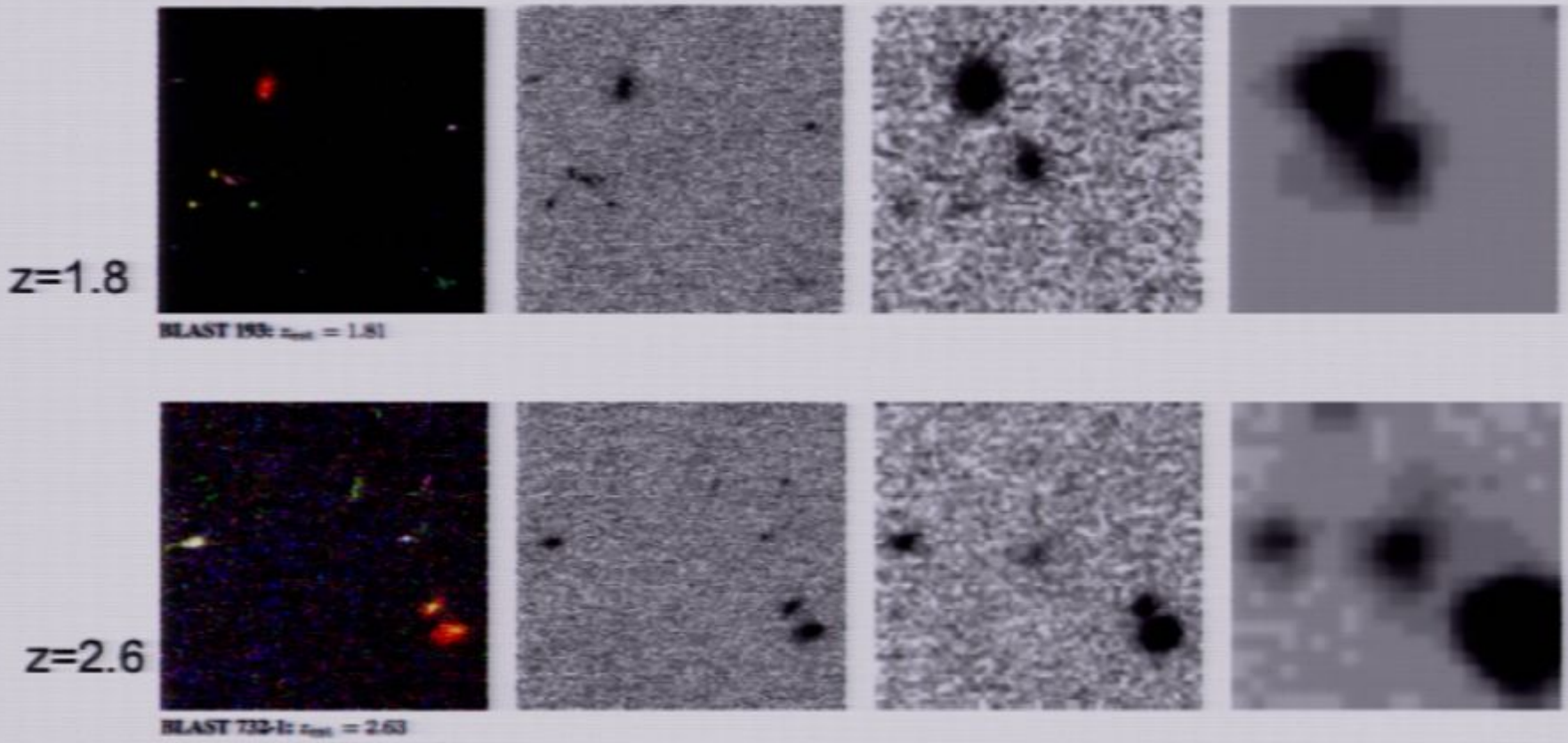
Introducing sub-mm galaxies



Luminous, dust-enshrouded galaxies.

~1000 galaxies per sq. deg. at $2 < z < 5$?

HST – Spitzer images of sub-submm galaxies



Optical/IR counterparts to BLAST 250 micron galaxies

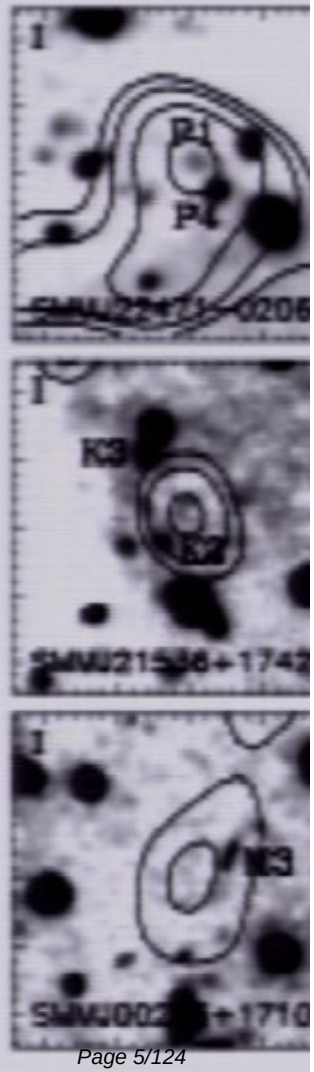
Submm galaxies: what do we know?

- High star-formation rates ~ 100s $M_\odot$/year, but optically obscured by dust
- Rare at low-z, but the dominant population at high-z: ~equally bright between z~2-10!
- Emit a modified black-body spectrum with emissivity $\varepsilon \propto \nu^{\beta}$ temperature $T = 20 - 40K$ and SED

$$S_\nu^{gal} = \varepsilon B_\nu \propto \frac{\nu^{3+\beta}}{e^{h\nu / K_B T_{gal}} - 1}$$

- Progenitors of large elliptical galaxies

e.g. Blain et al 2002



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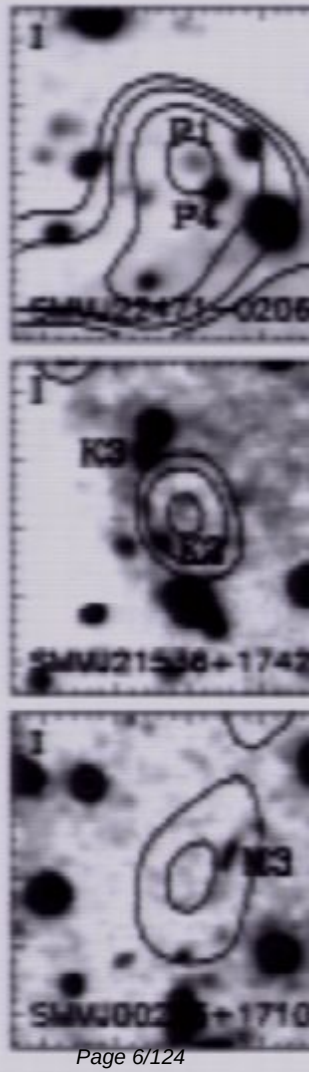

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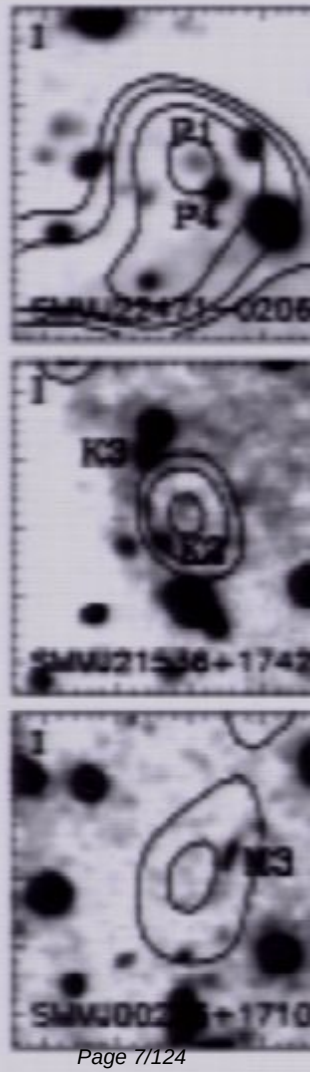

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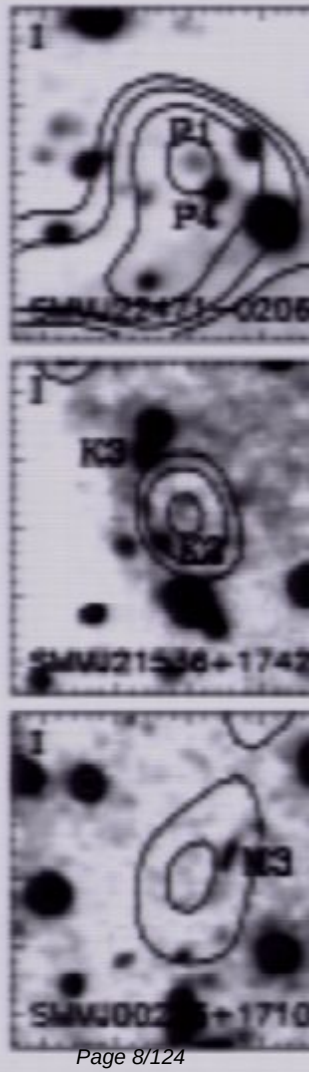

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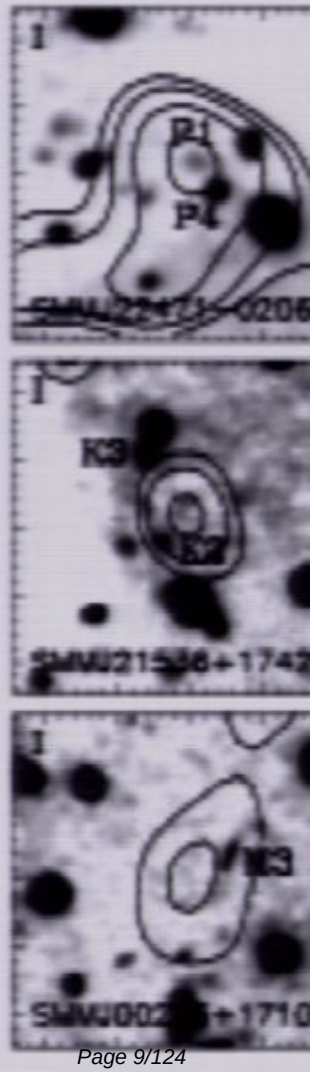

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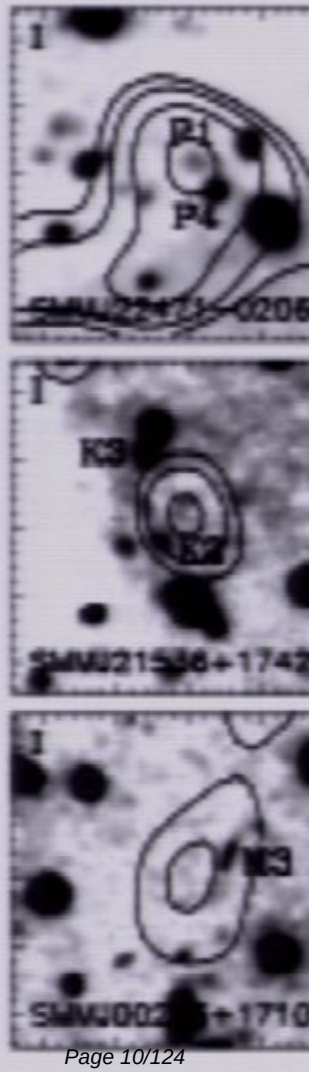

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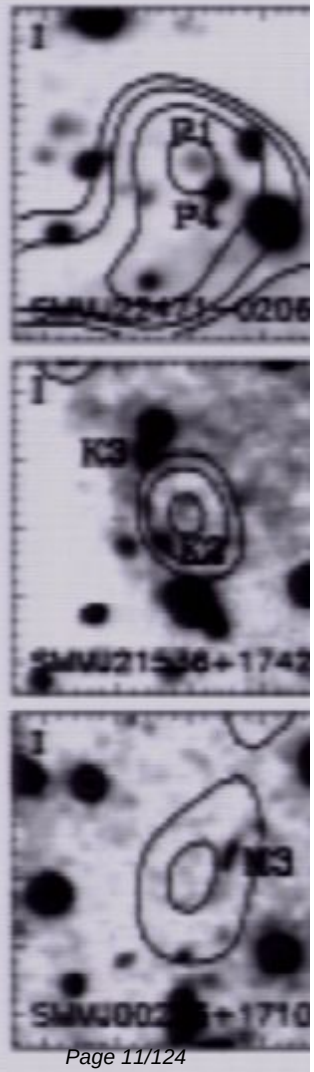

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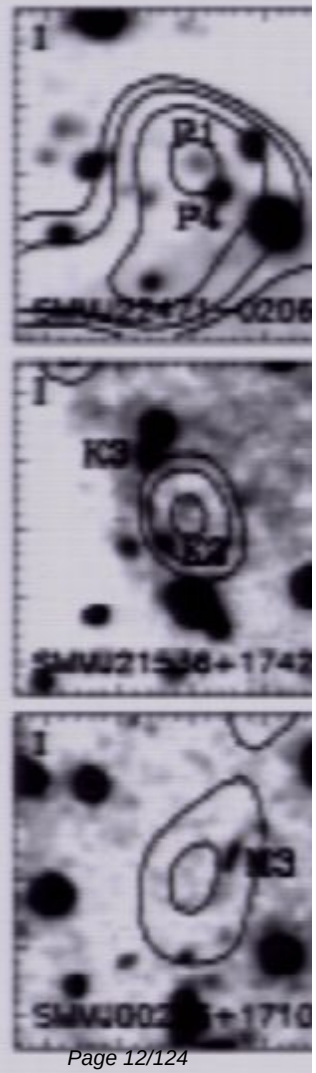

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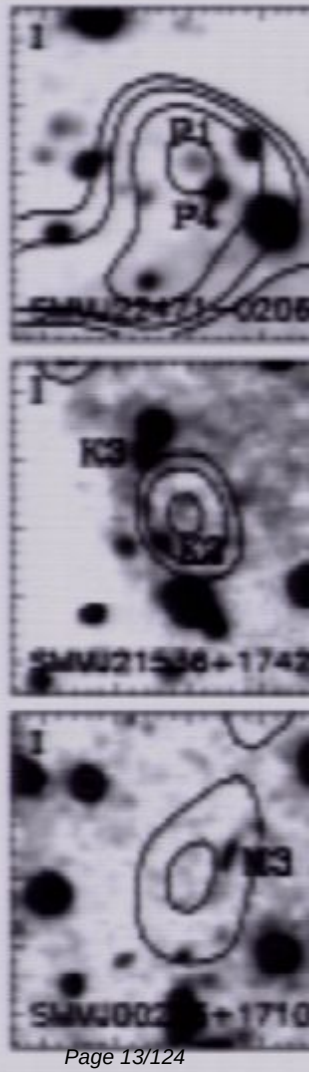

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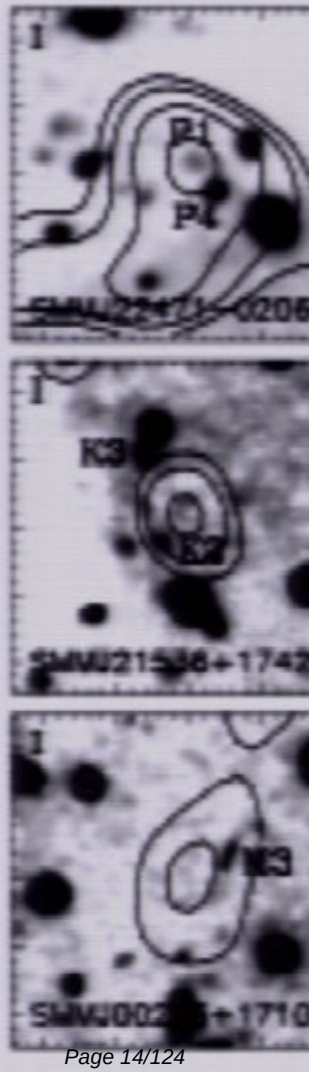

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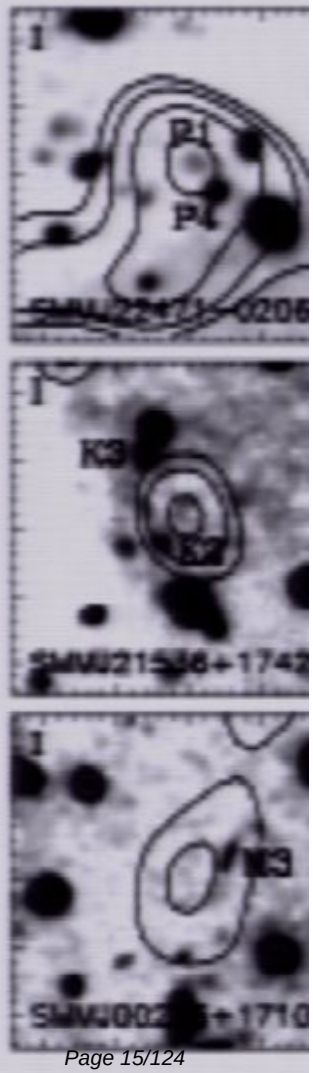

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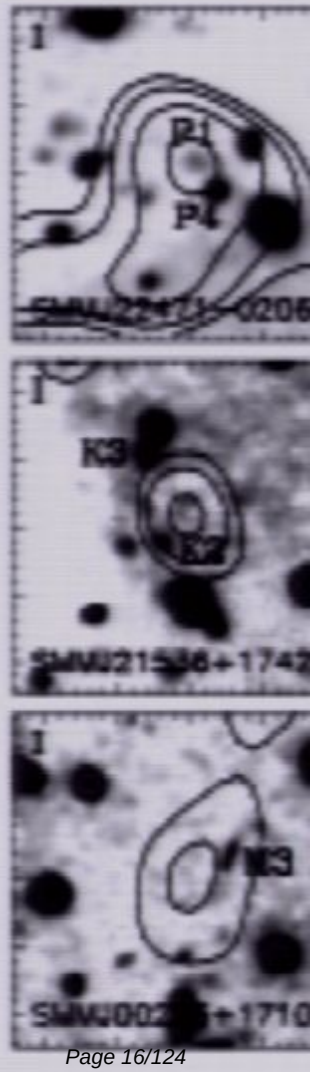

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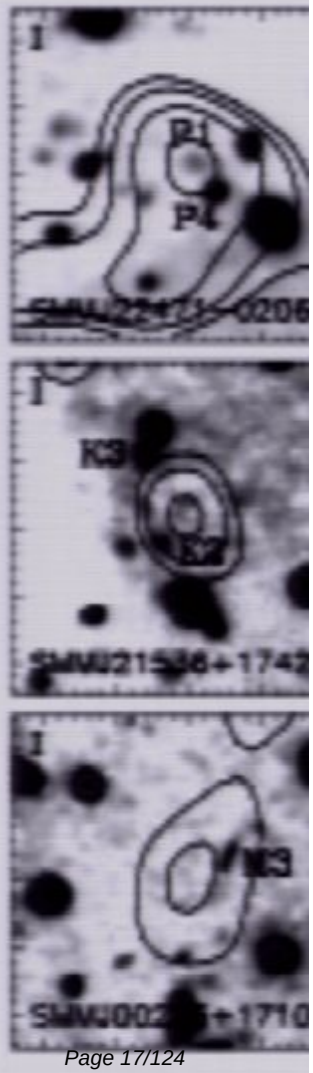

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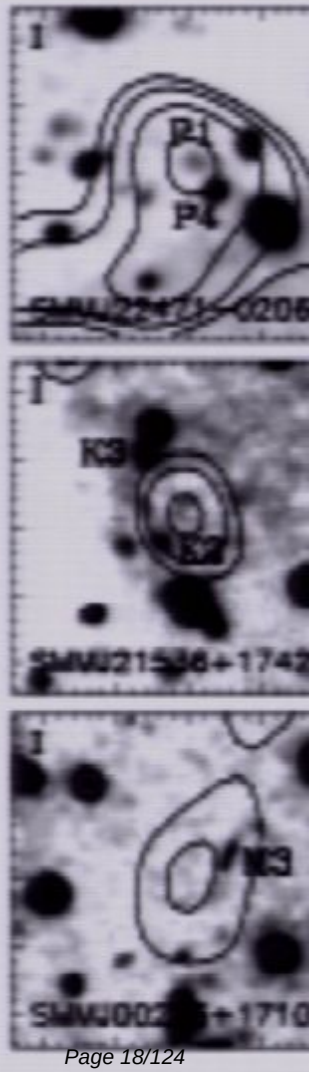

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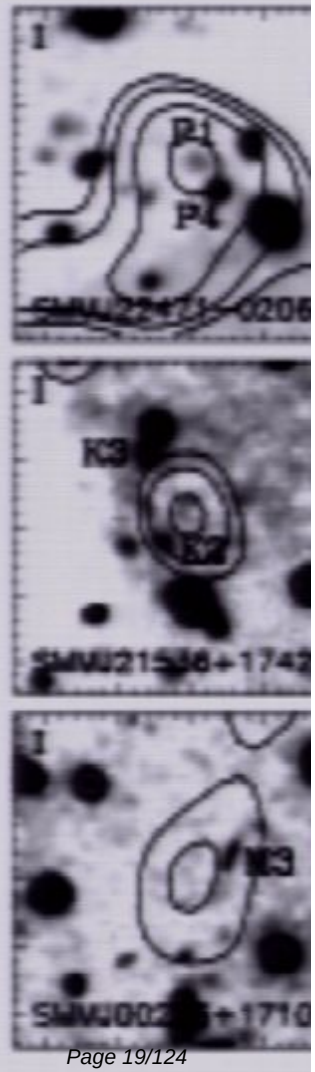

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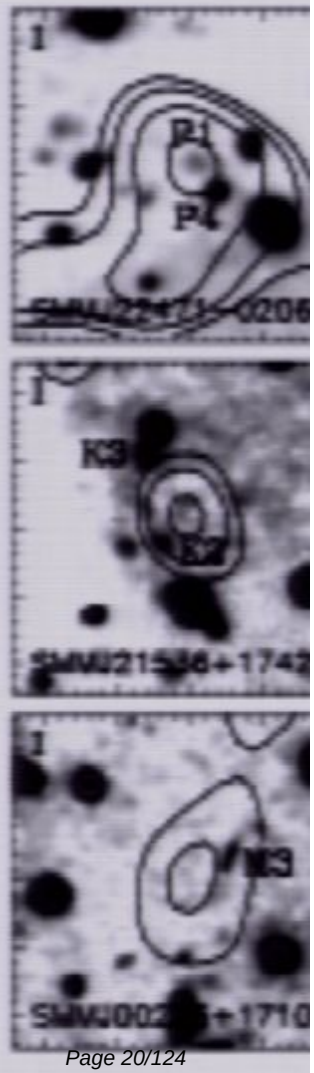

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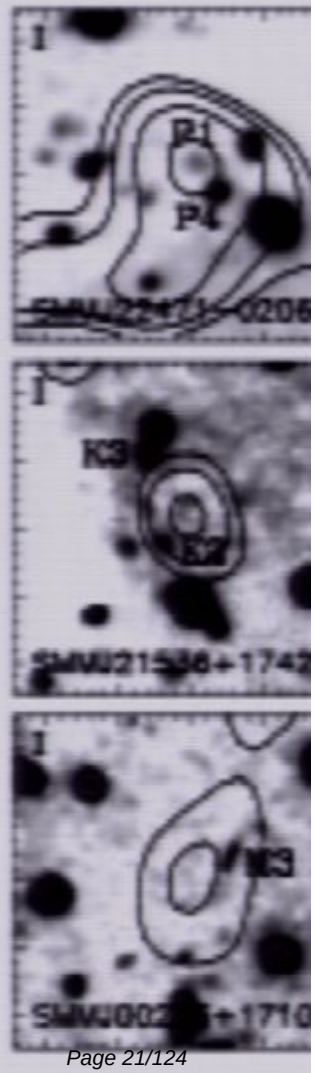

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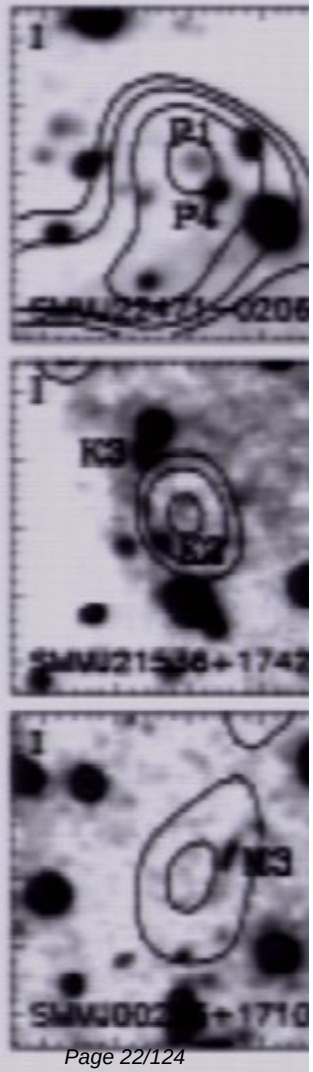

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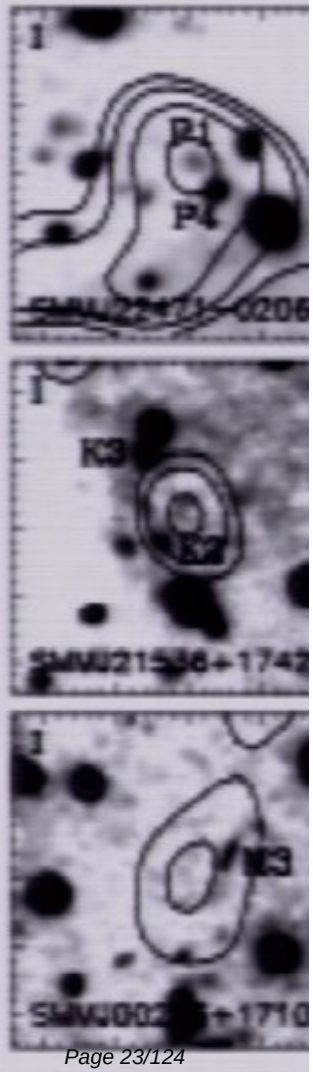

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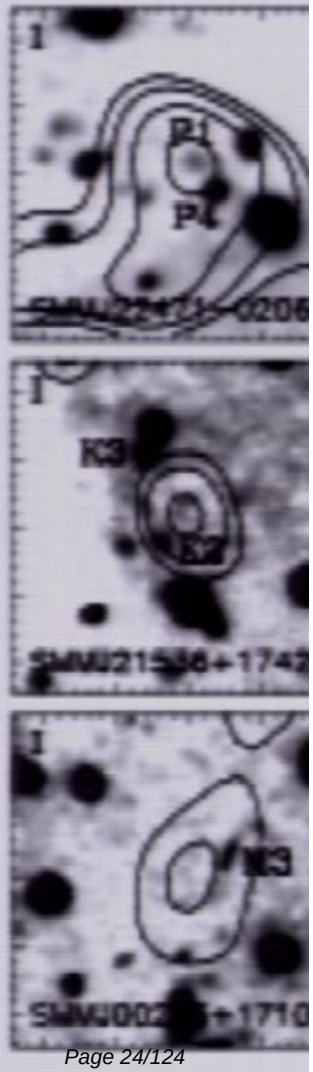
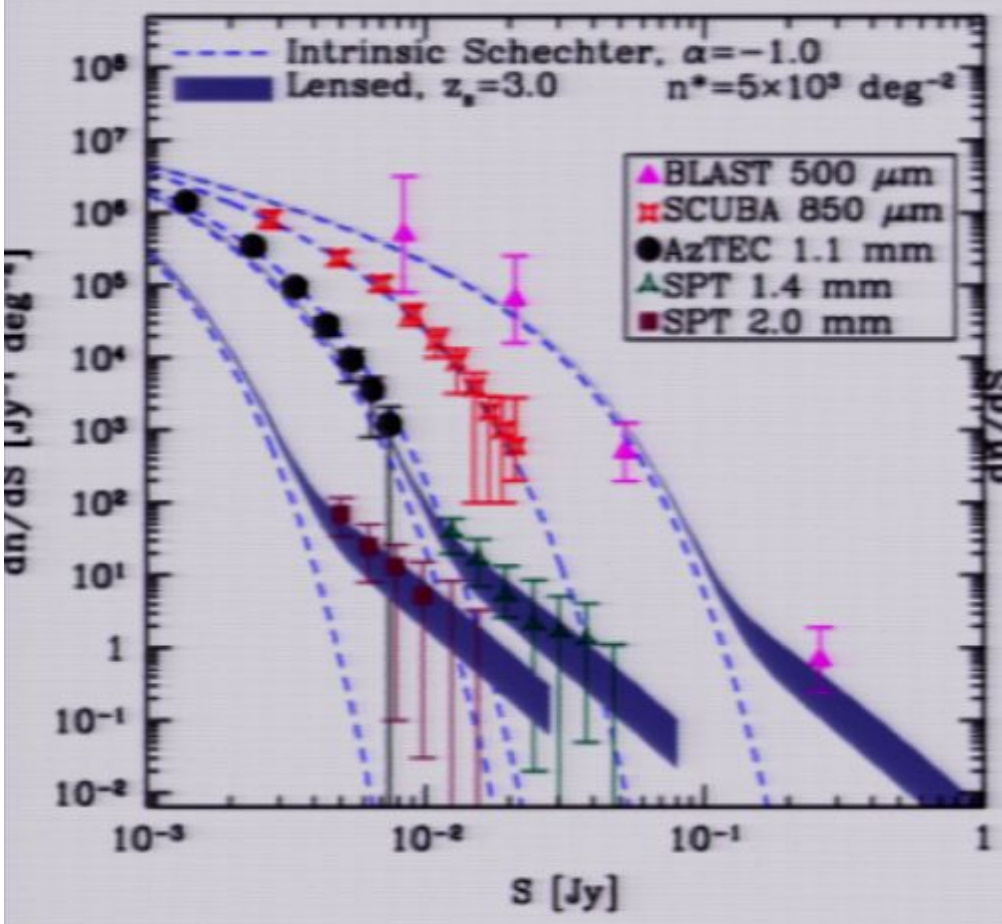
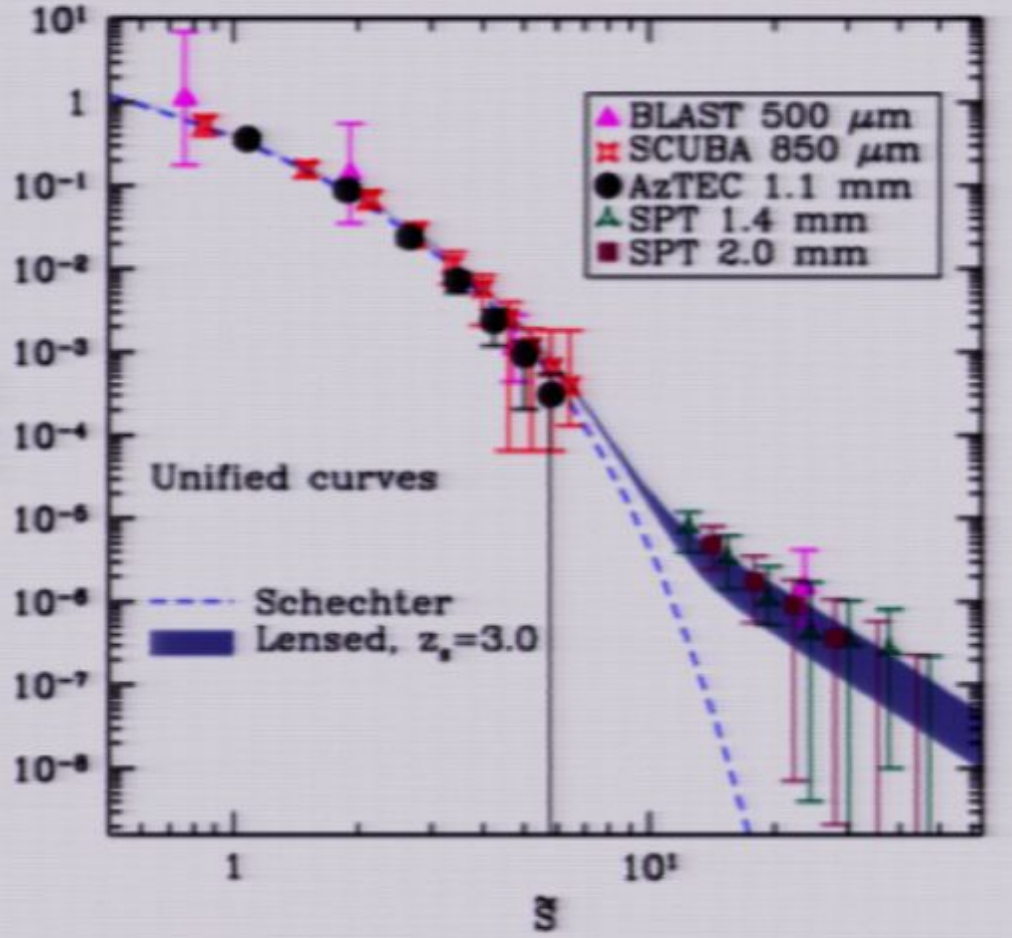


Single population at z=3: Schechter function + magnification





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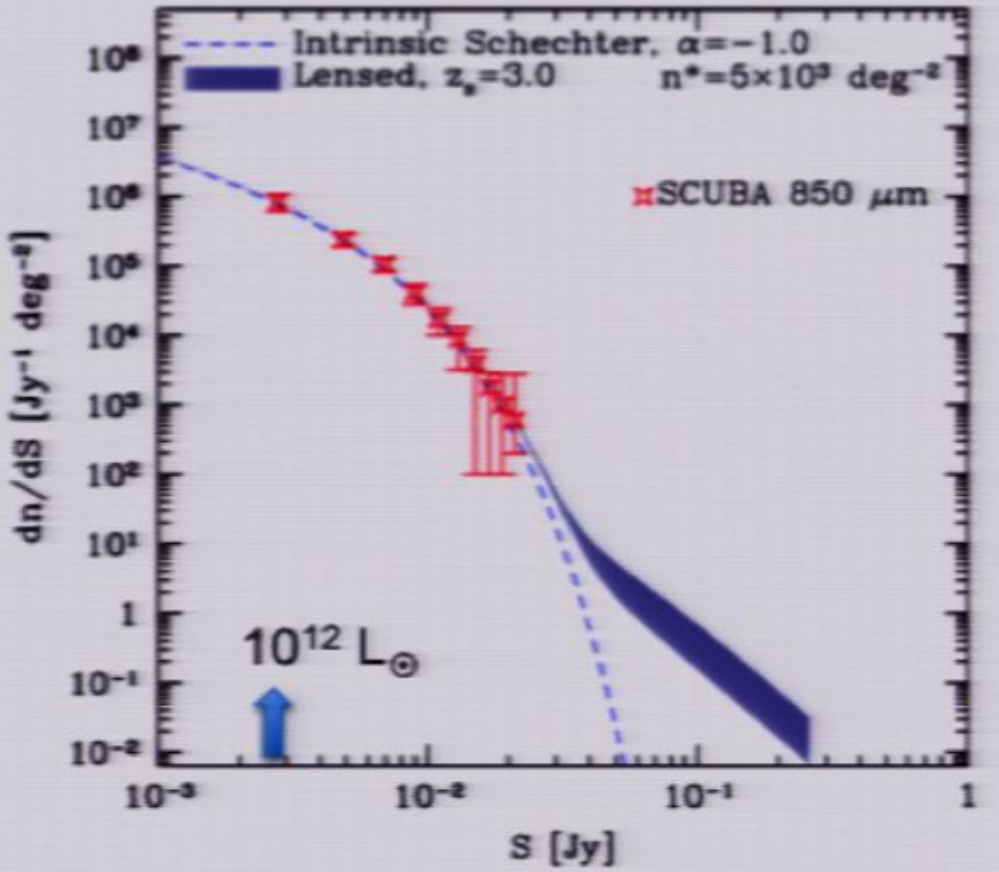

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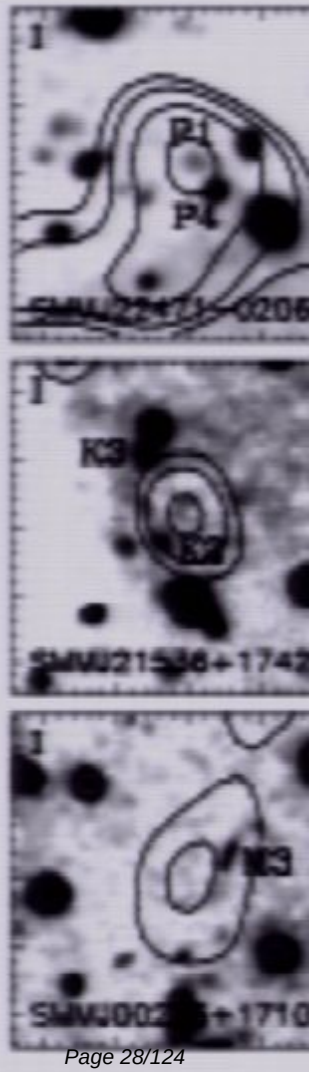

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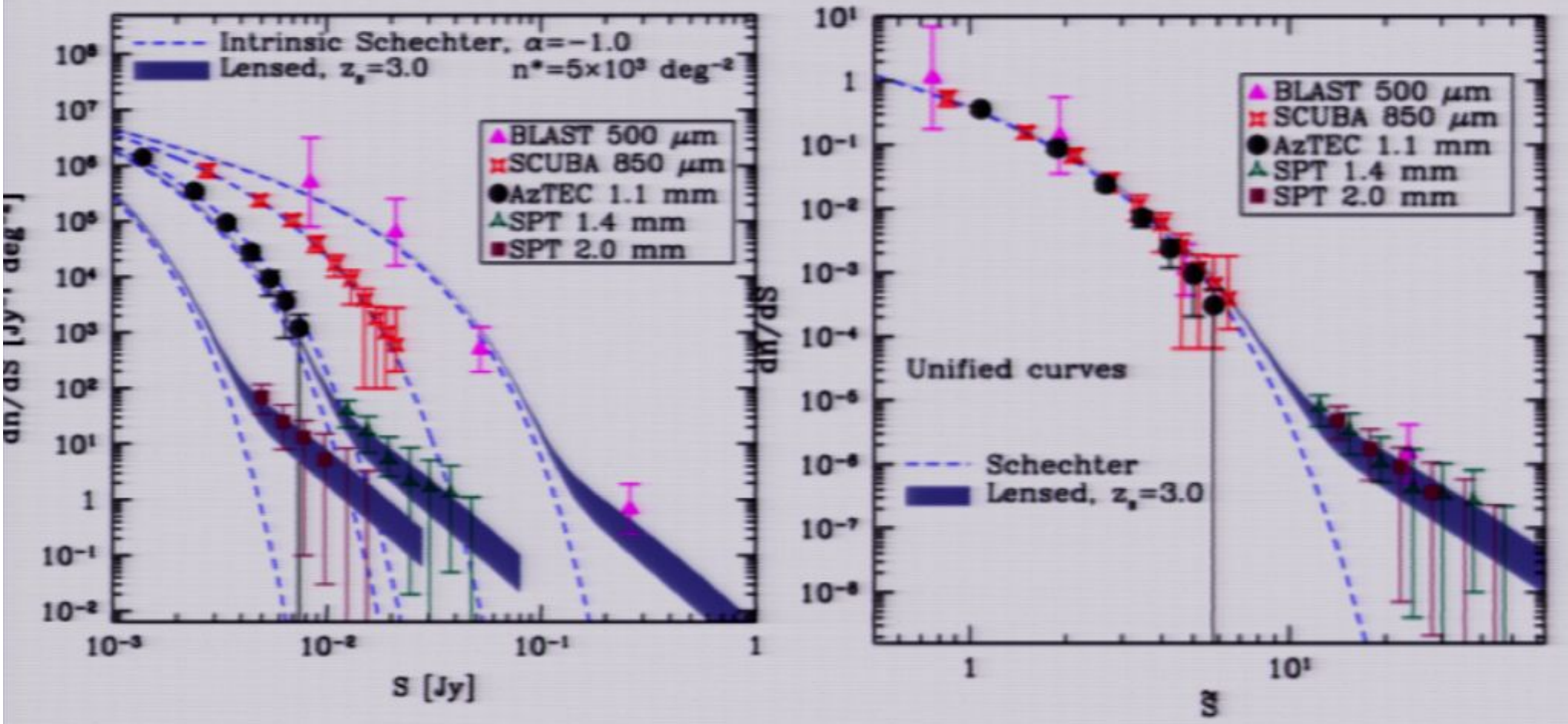

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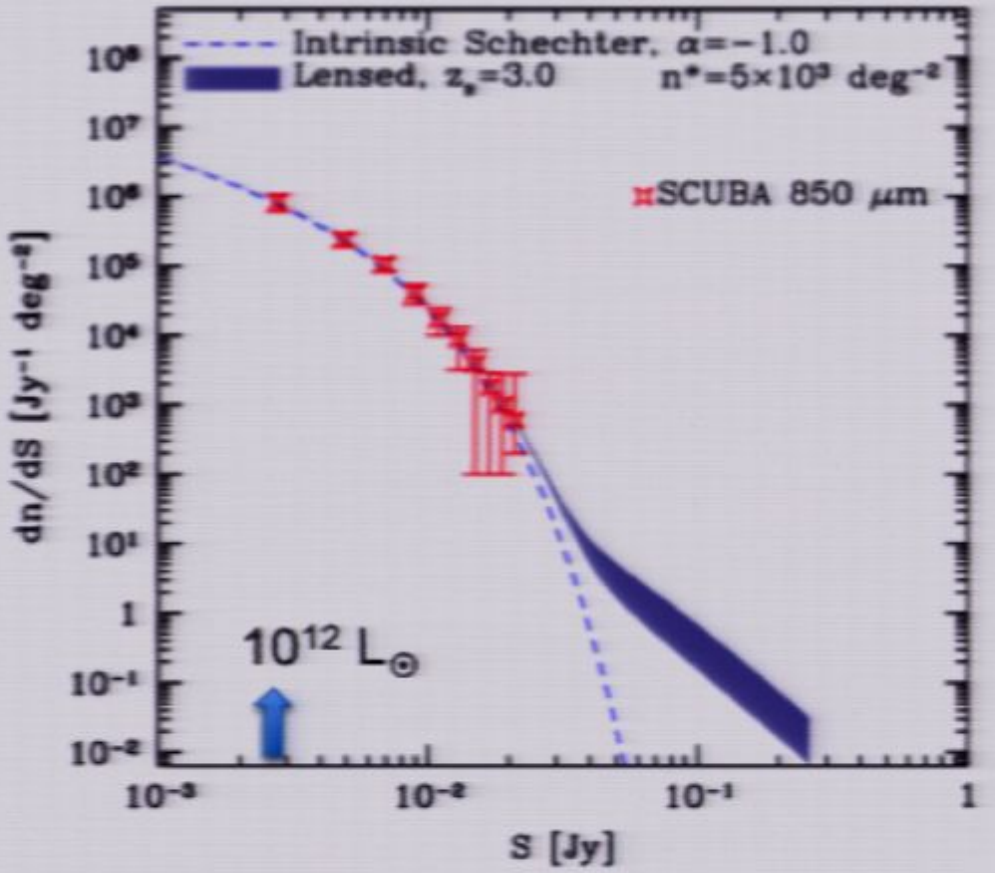

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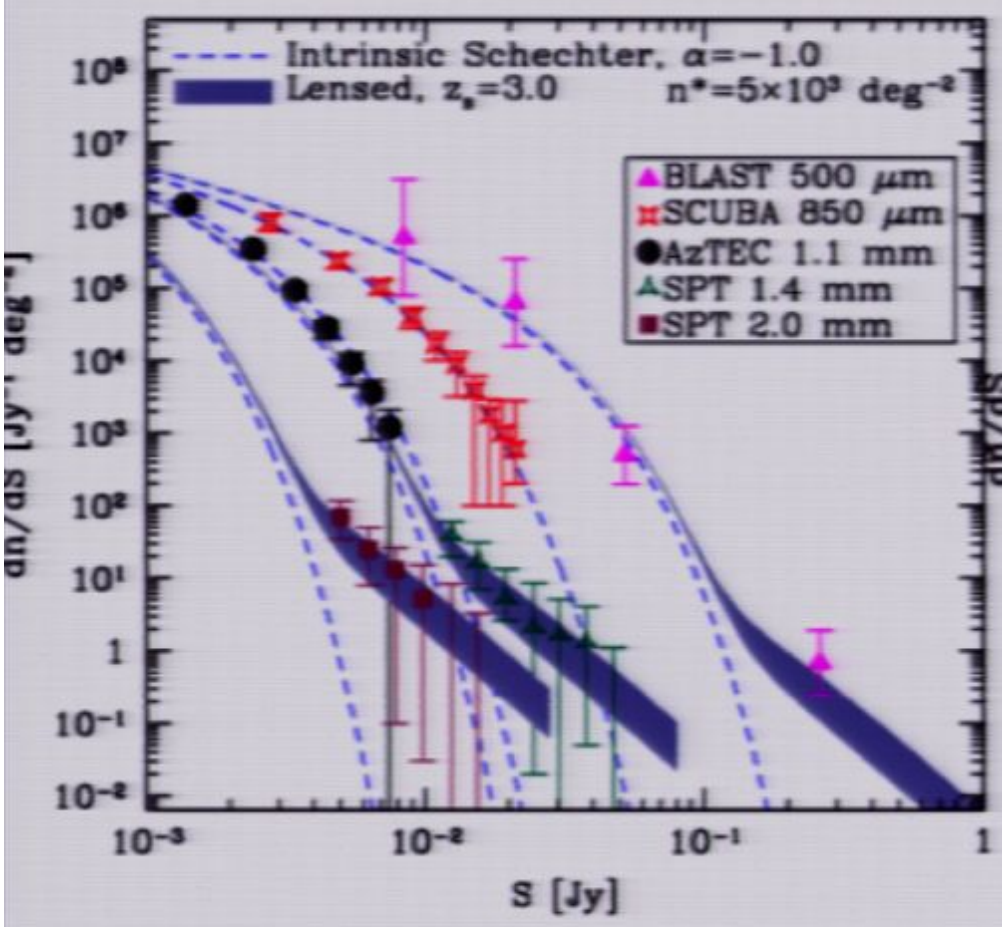

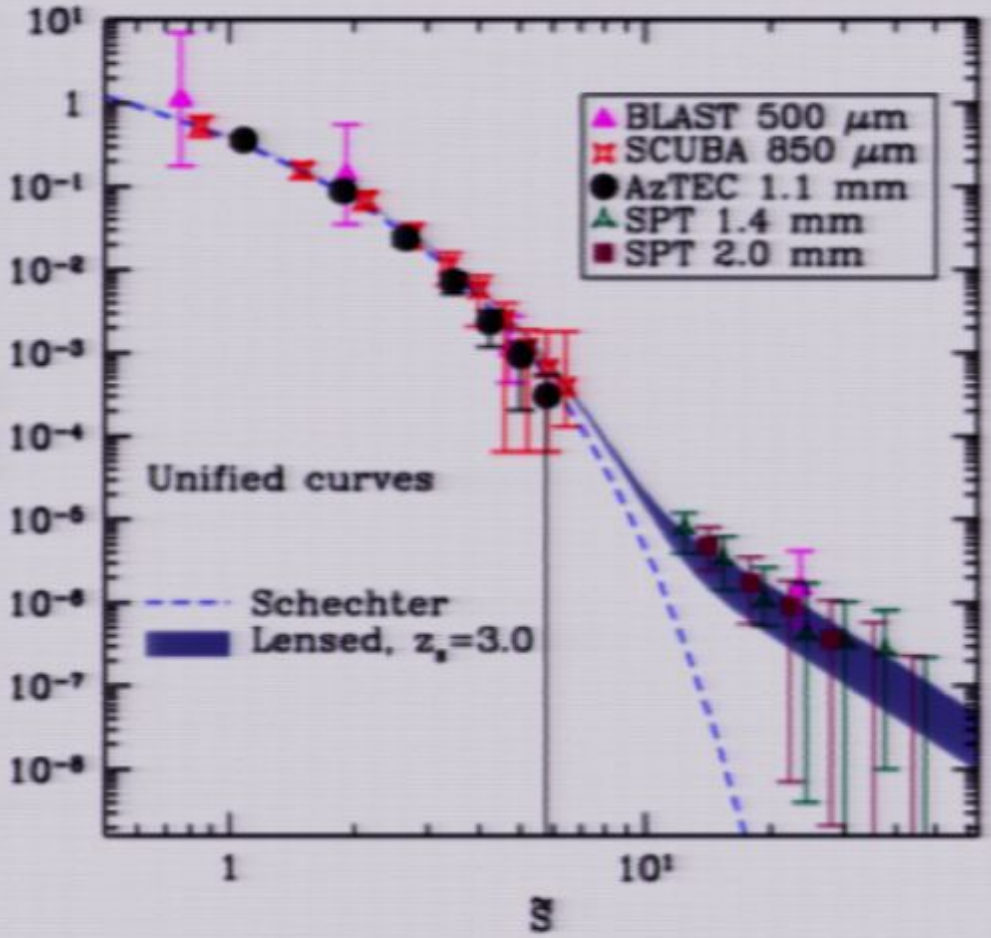

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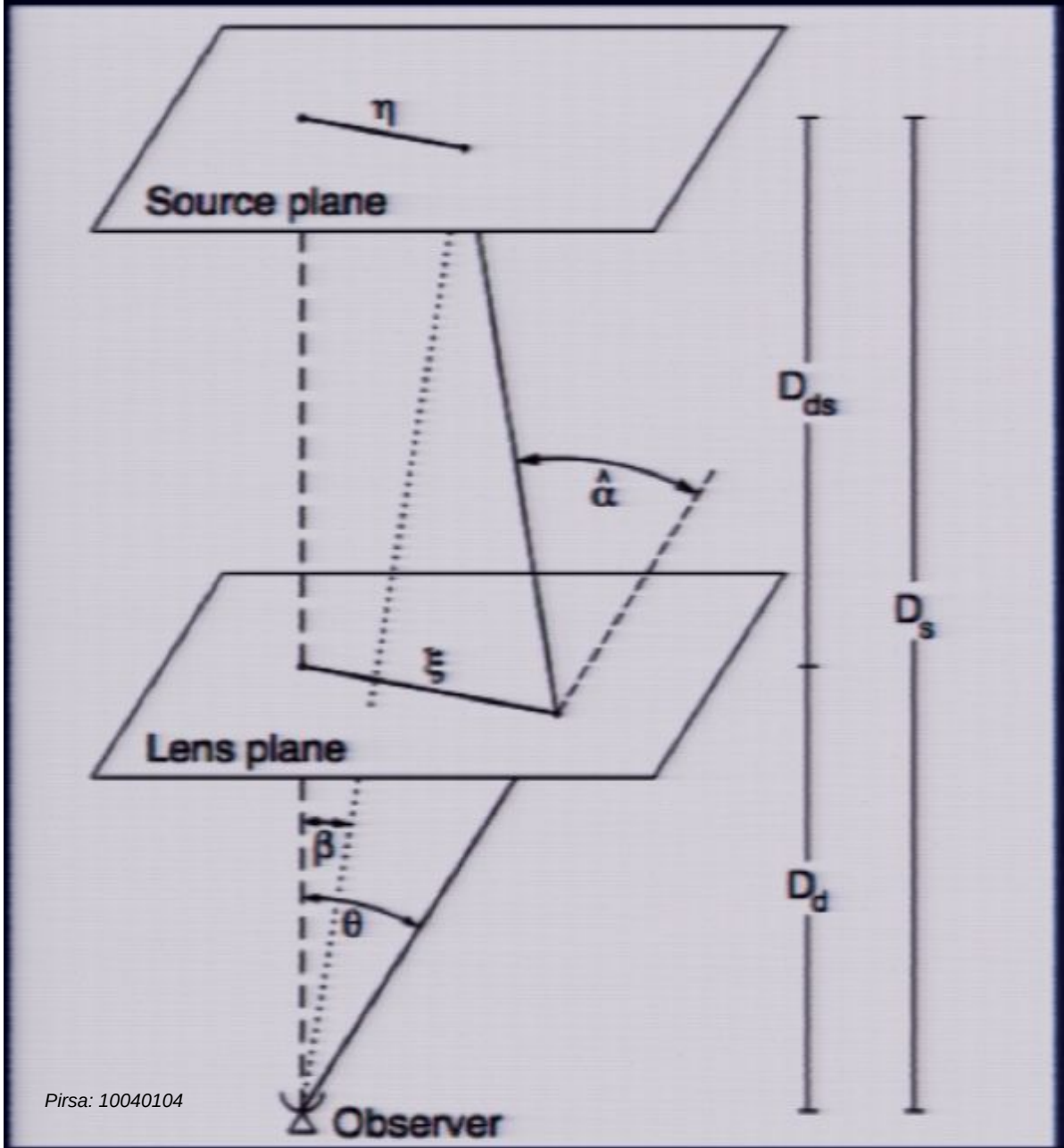


- **Lens equation:** $\vec{\beta} = \vec{\theta}$ -
- Transformation matrix

$$A_{ij} = \frac{\partial \beta_i}{\partial \theta_j} = \delta_{ij} - \frac{\partial \beta_i}{\partial \theta_j}$$

- **Magnification:** $\mu = \det$

$$\mu = \frac{1}{(1-\kappa)^2 - |\gamma|^2}$$

- Probability: $P(\mu)$ in fields and clusters.

Lensing Halos

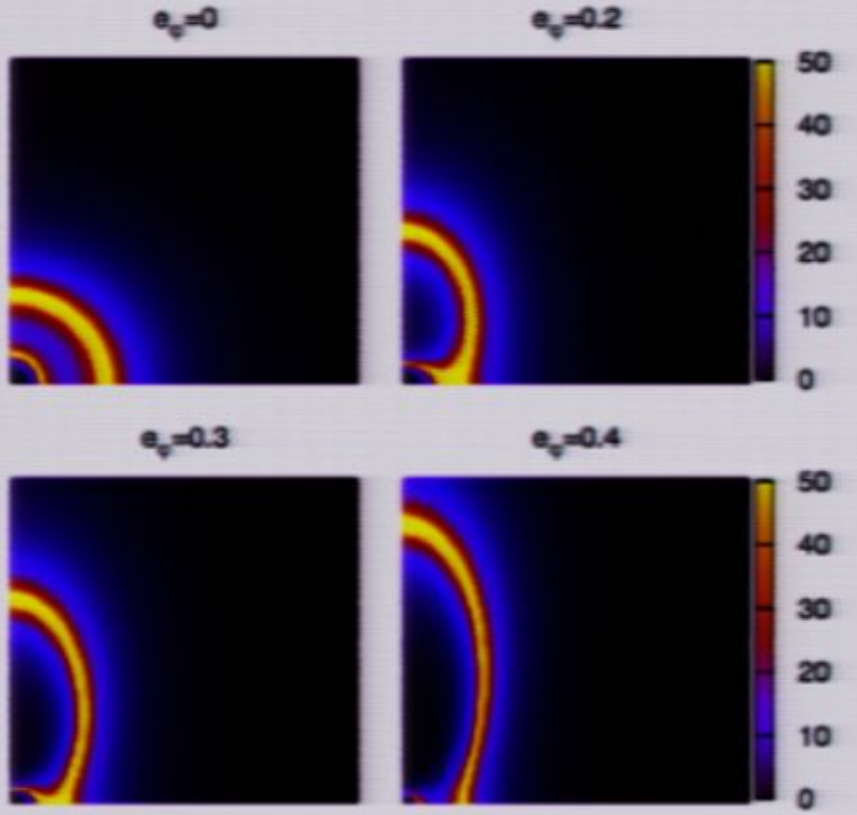
$$\rho(r) = \frac{\rho_s}{r/r_s\left(1+r/r_s\right)^2}$$

- Magnification follows analytically from surface density, convergence and shear

$$\rho(r) \rightarrow \Sigma(\theta) \rightarrow \kappa(\theta) \rightarrow \bar{\kappa}(<\theta) \rightarrow \gamma(\theta) \rightarrow \mu(\theta)$$

- Add ellipticity e_φ in lensing potential
- Propagate to $\mu(\theta_1,\theta_2)$

Elliptical Halos: Magnification Maps



Magnification cross-section on the sky:

$$\Delta\Omega_\mu = \int_{\mu'(\theta)>\mu} d\theta^2$$

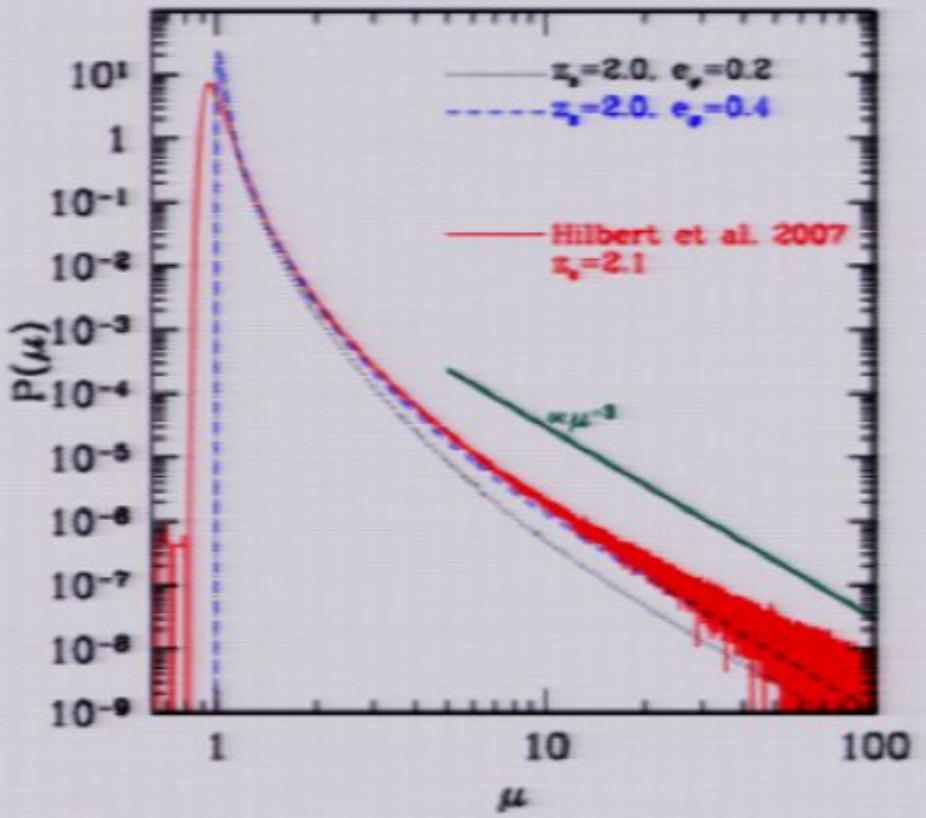
$$M_{halo} = 10^{15} h^{-1} M_{sun} \quad z_l = 0.5 \quad z_s = 2.0$$

Lensing Probability

- The optical depth from intervening halos

$$\int_0^{z_s} dz_l \frac{D_A^2(z_l)}{H(z_l)} \int_{M_{th}}^{\infty} dM \frac{dn(z_l,M)}{dM} \Delta\Omega_\mu$$

- Gives magnification probability P(μ)



Magnification effects on galaxy number counts

- Lensing: $S_{obs} = \mu\, S$; $d\Omega_{obs} = \mu\, d\Omega$

- Differential counts: constant μ

$$\frac{dn_{obs}(S_{obs})}{dS_{obs}} = \frac{1}{\mu^2}\frac{dn}{dS}\left(\frac{S_{obs}}{\mu}\right)$$

- Differential counts: variable μ *(Jain & Lima 2010)*

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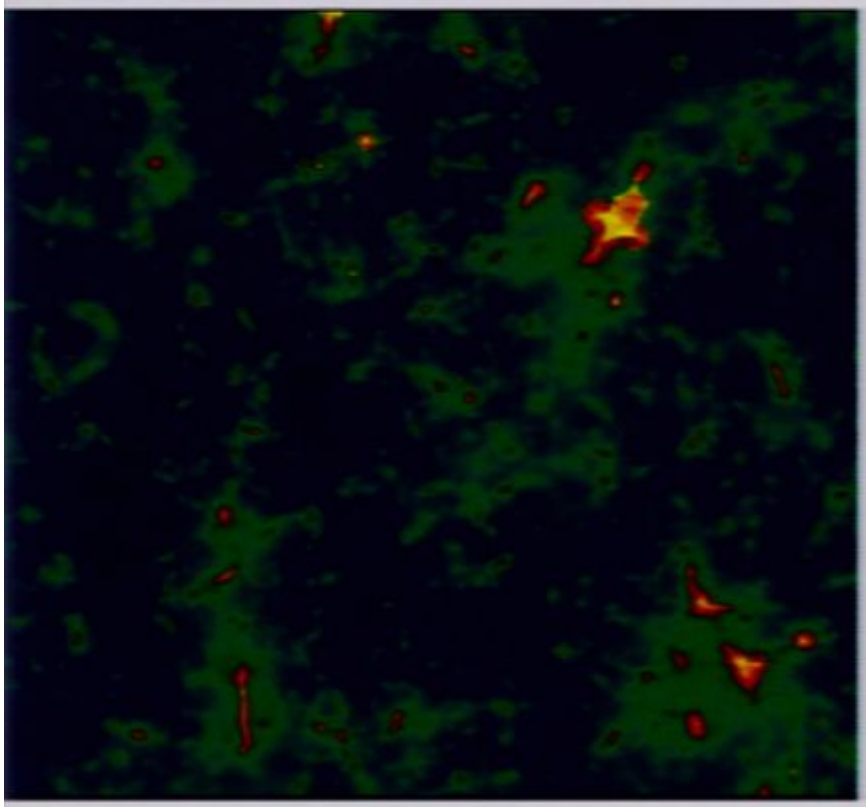

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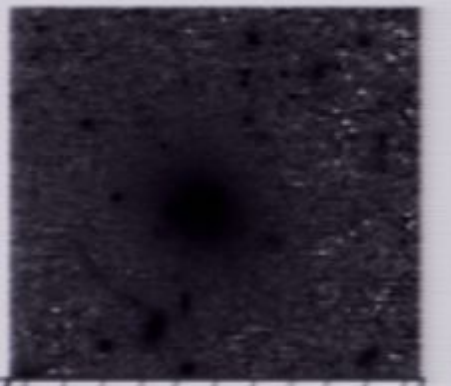

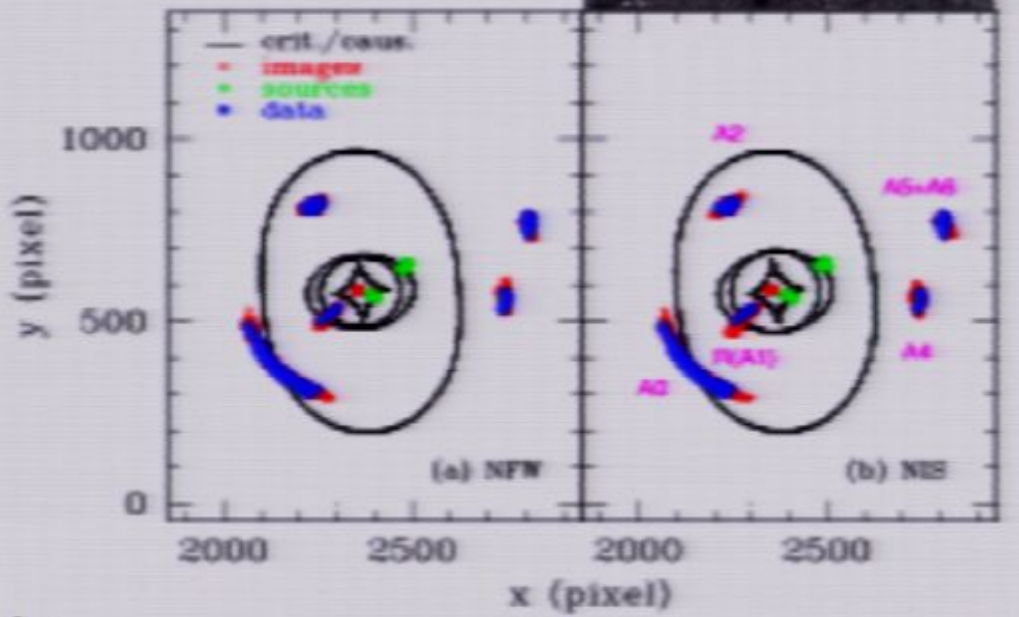

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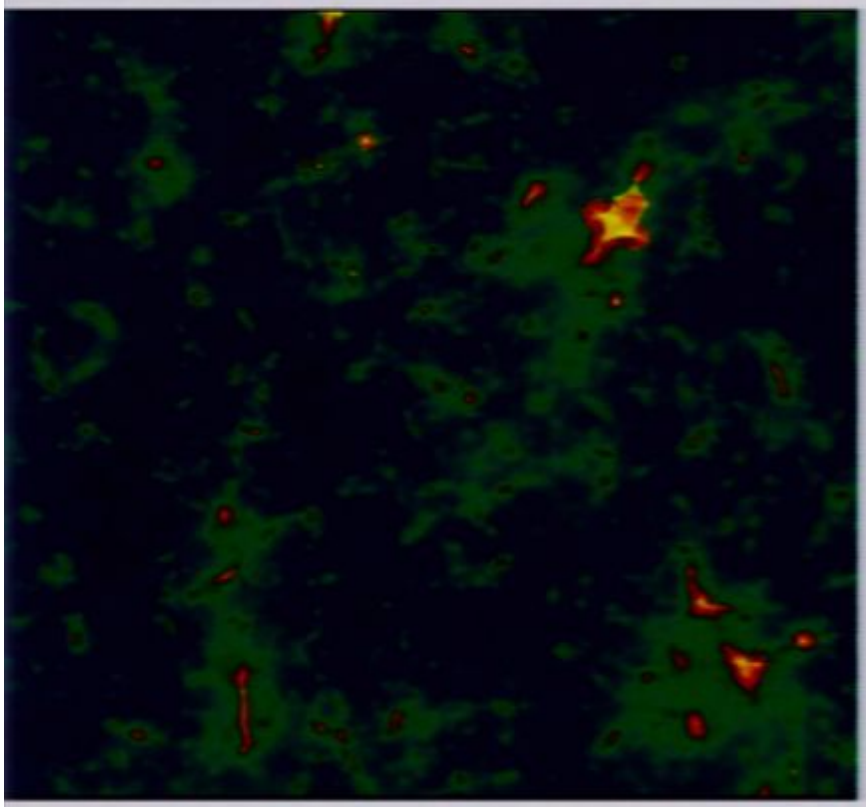

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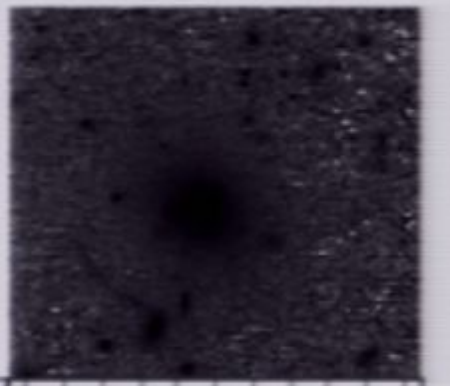

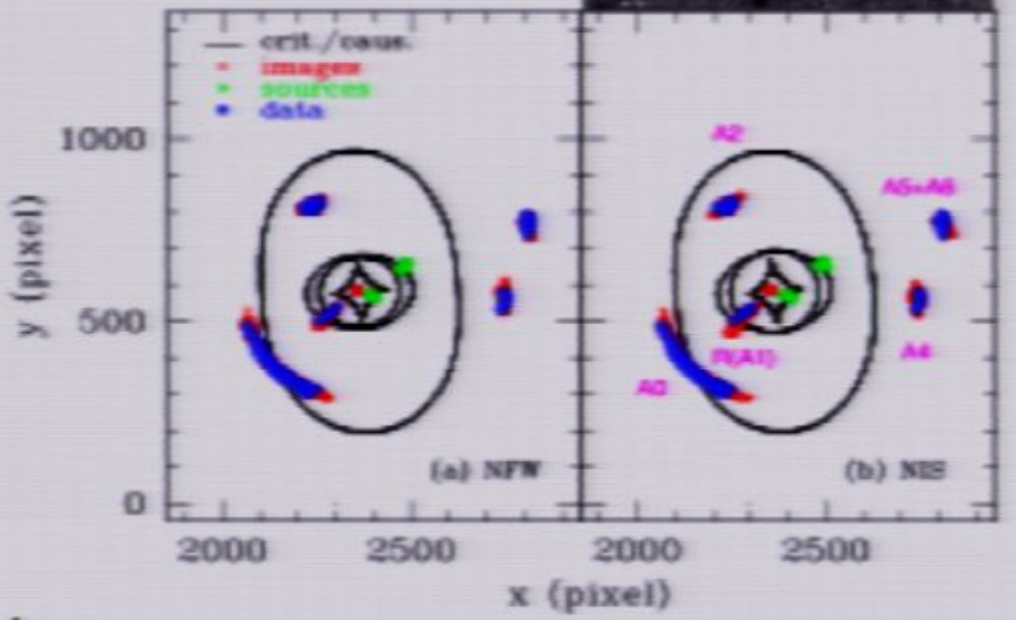

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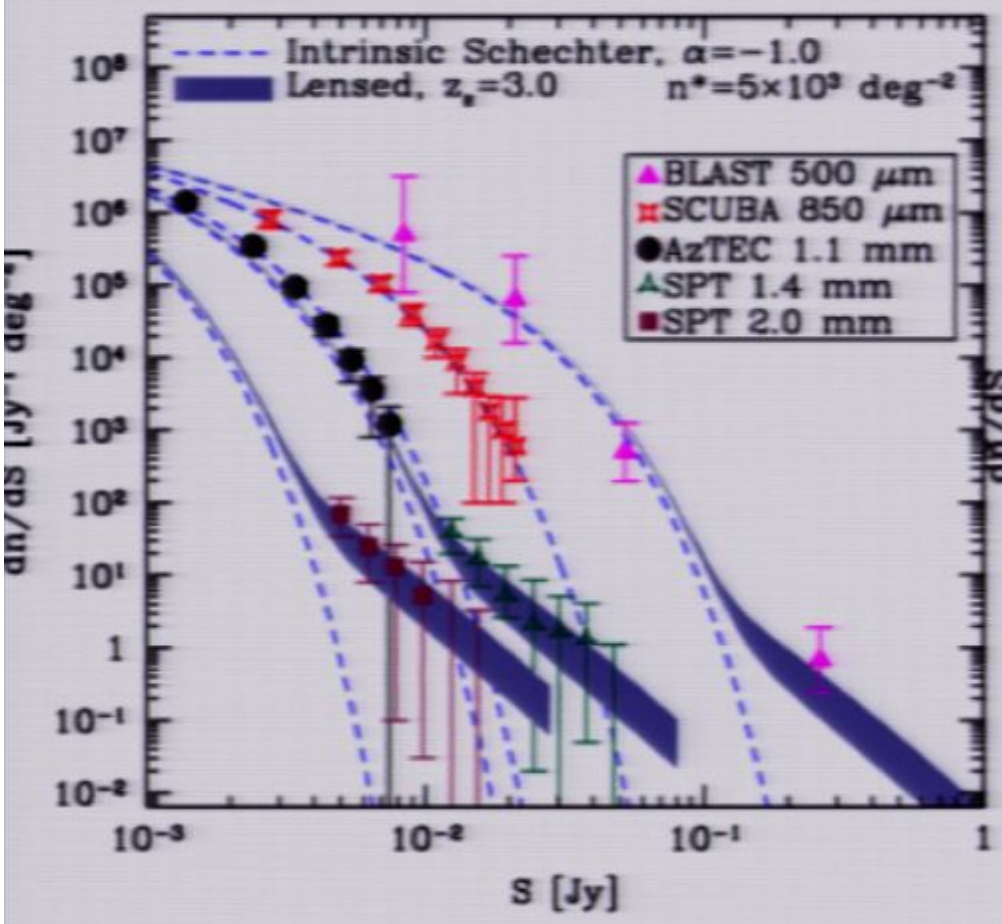
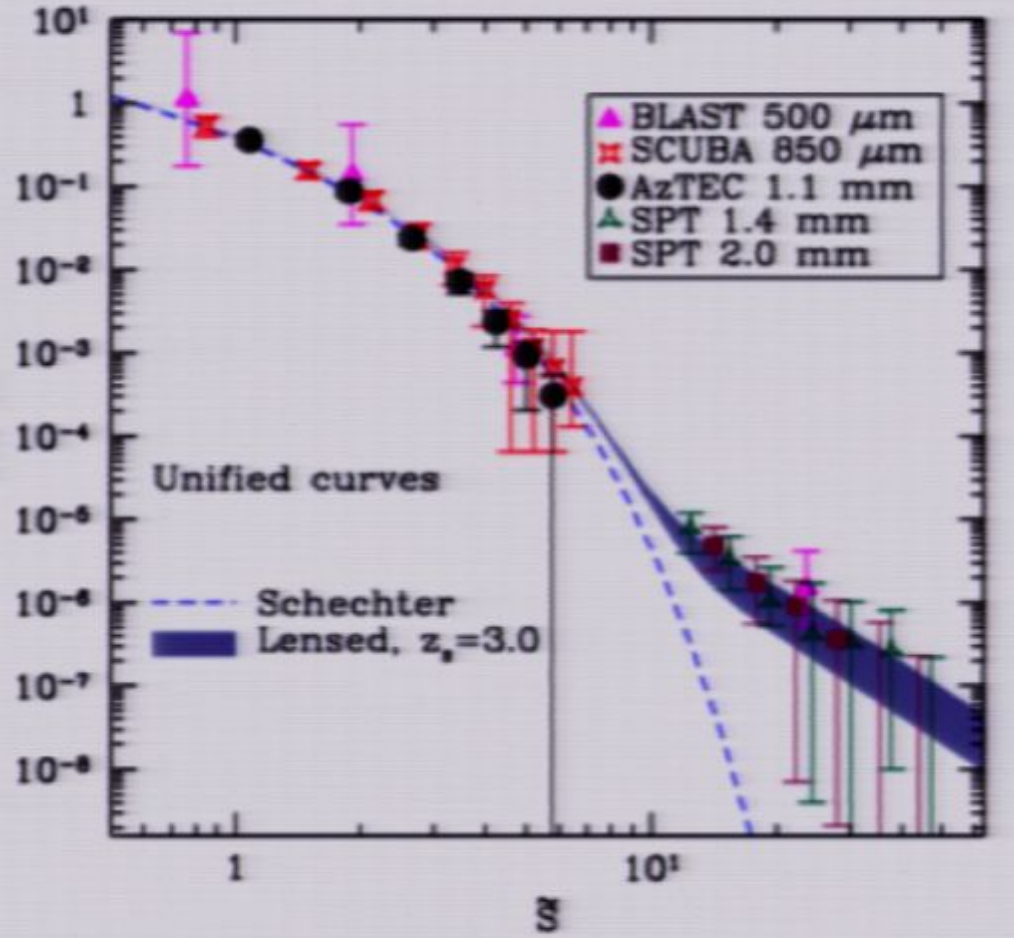
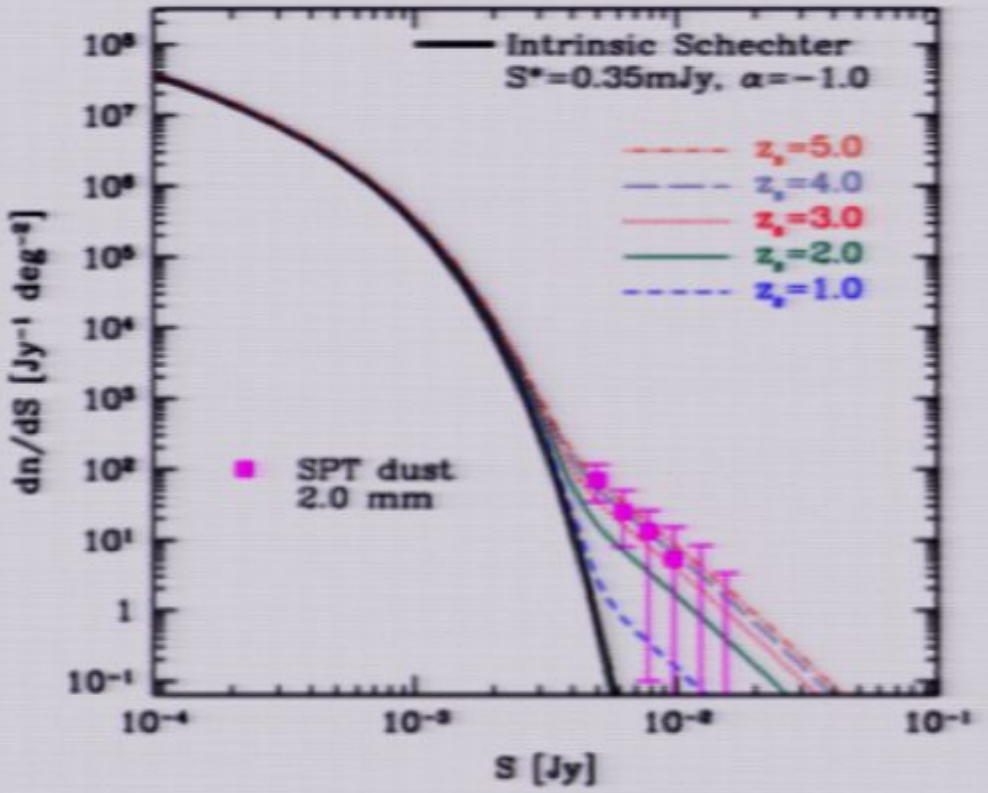




Lima, Jain, Devlin, Aguirre 2010

Source Galaxy Redshifts



Viera et al 2010

Bright SPT sources are likely at z>2

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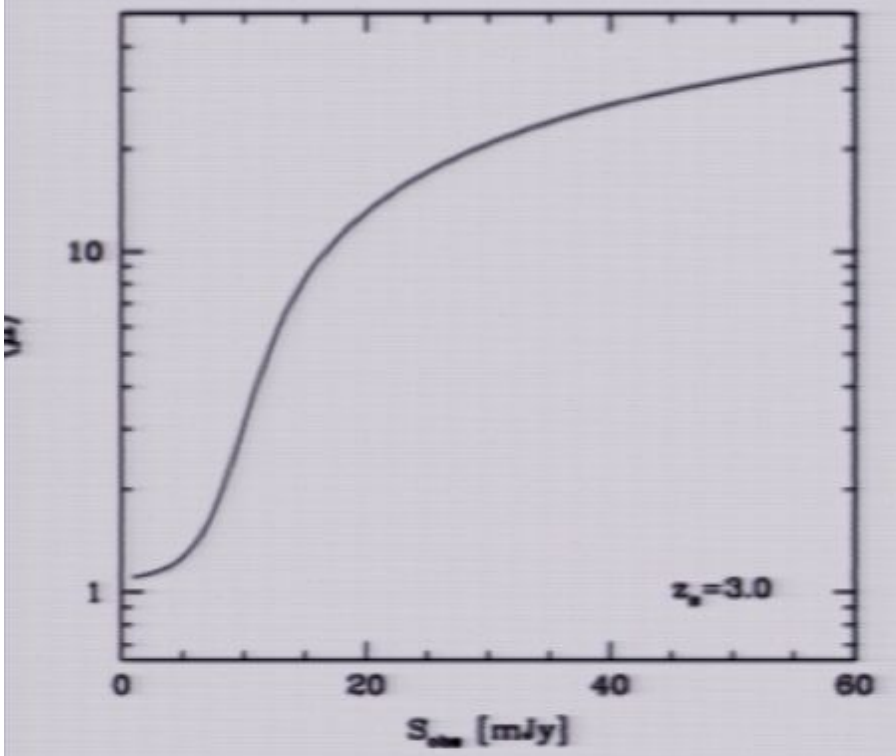

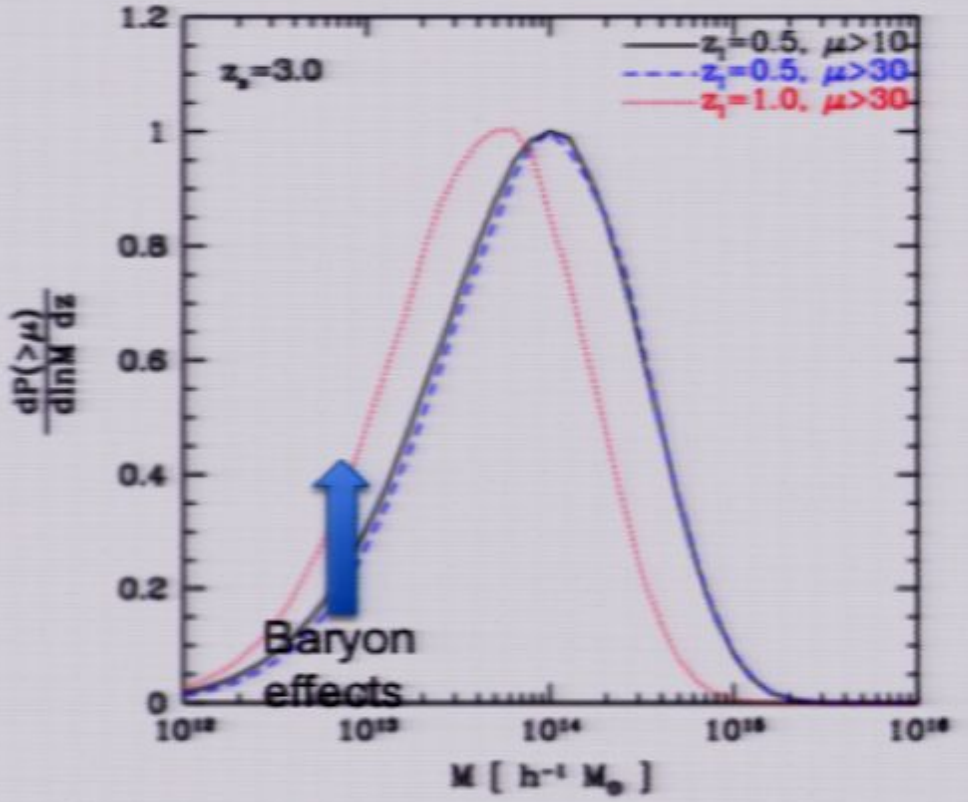

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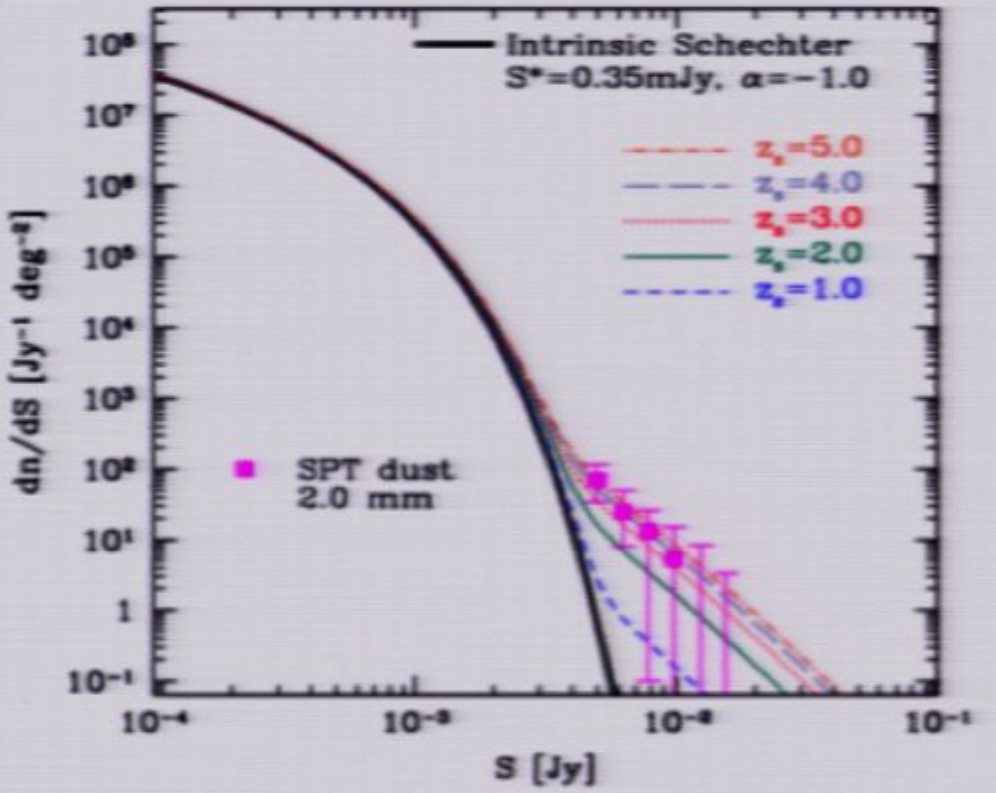

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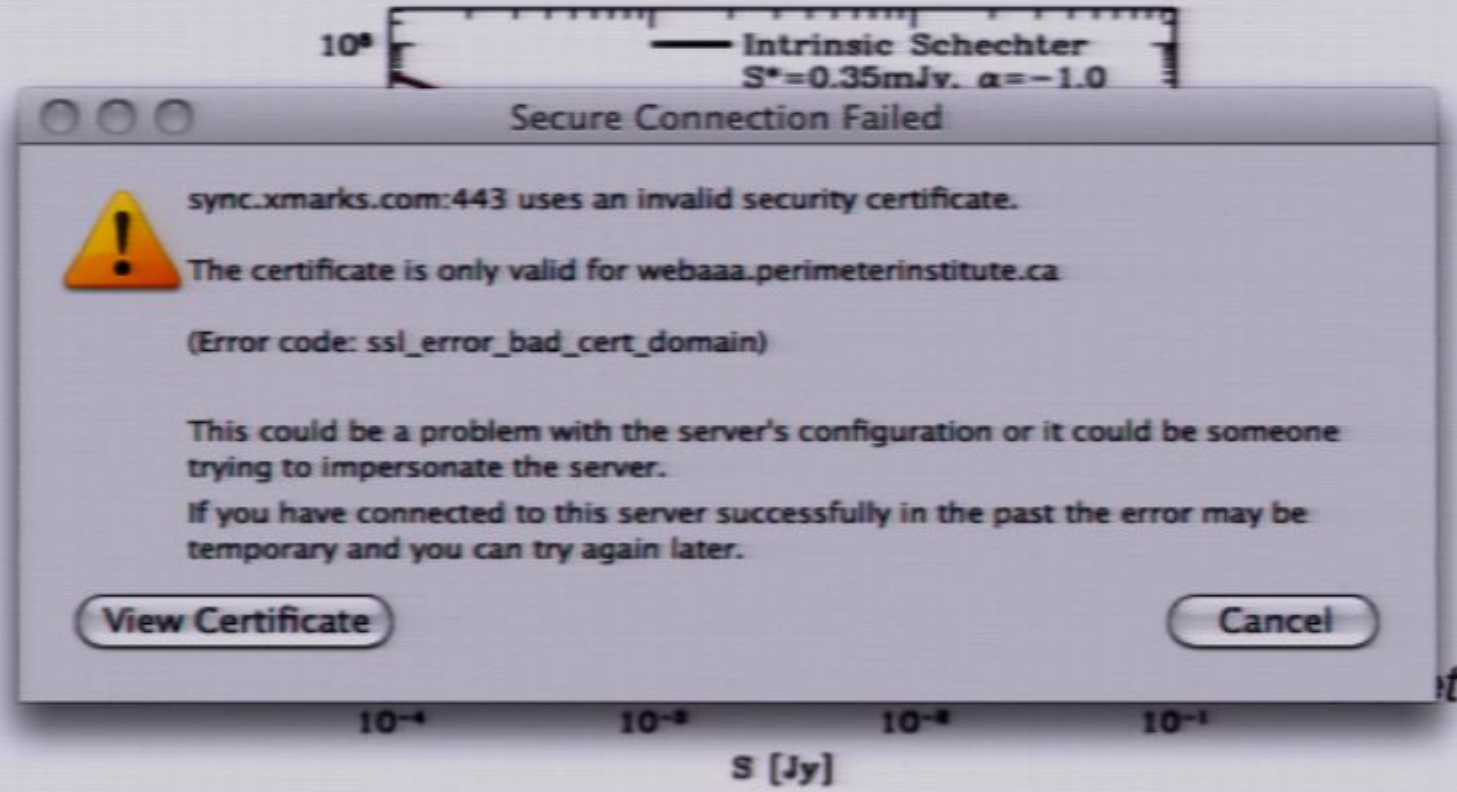

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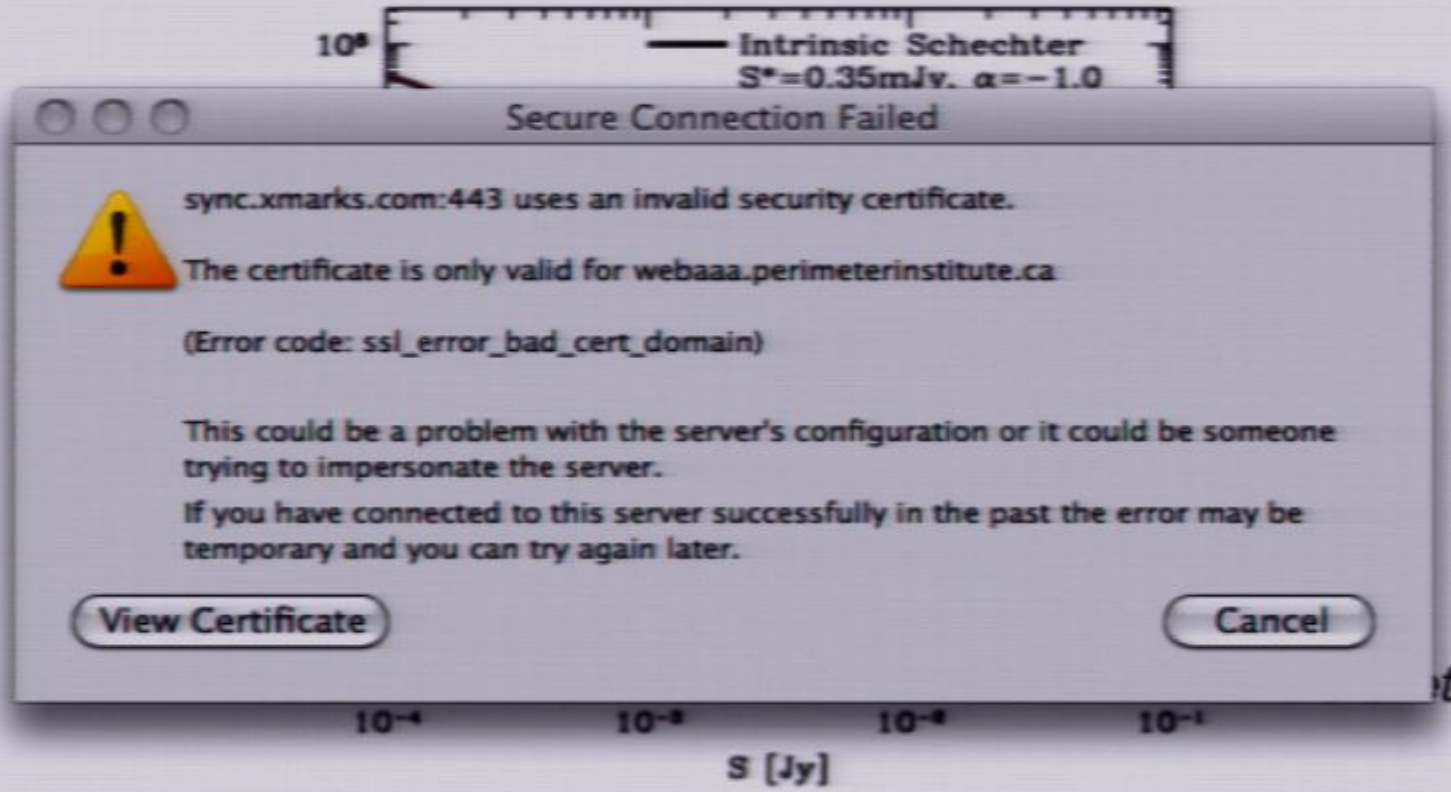

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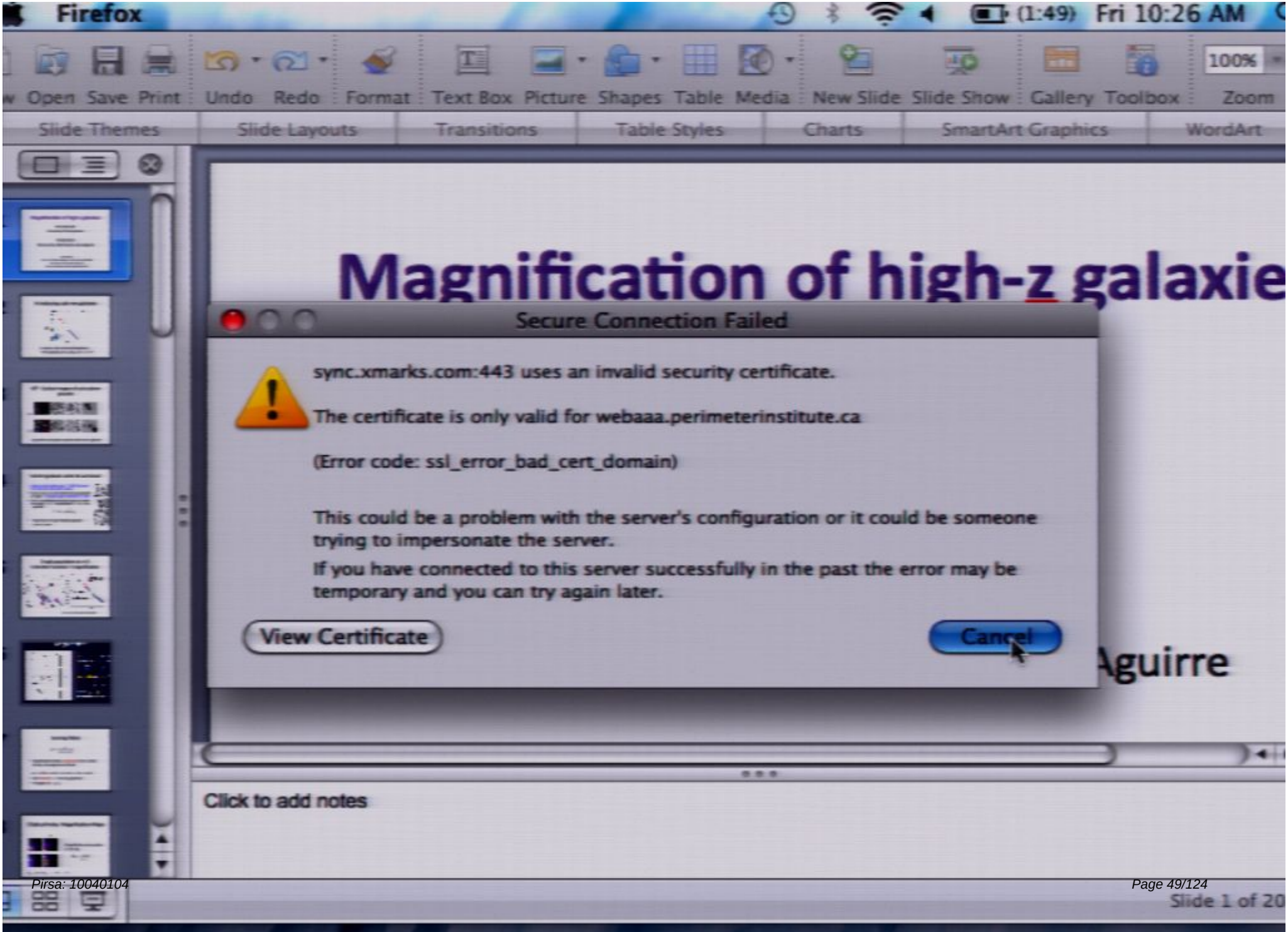
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Magnification of high-z galaxie
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sync.xmarks.com:443 uses an invalid security certificate.
The certificate is only valid for webaaa.perimeterinstitute.ca
(Error code: ssl_error_bad_cert_domain)
This could be a problem with the server's configuration or it could be someone trying to impersonate the server.
If you have connected to this server successfully in the past the error may be temporary and you can try again later.
View Certificate
Cancel
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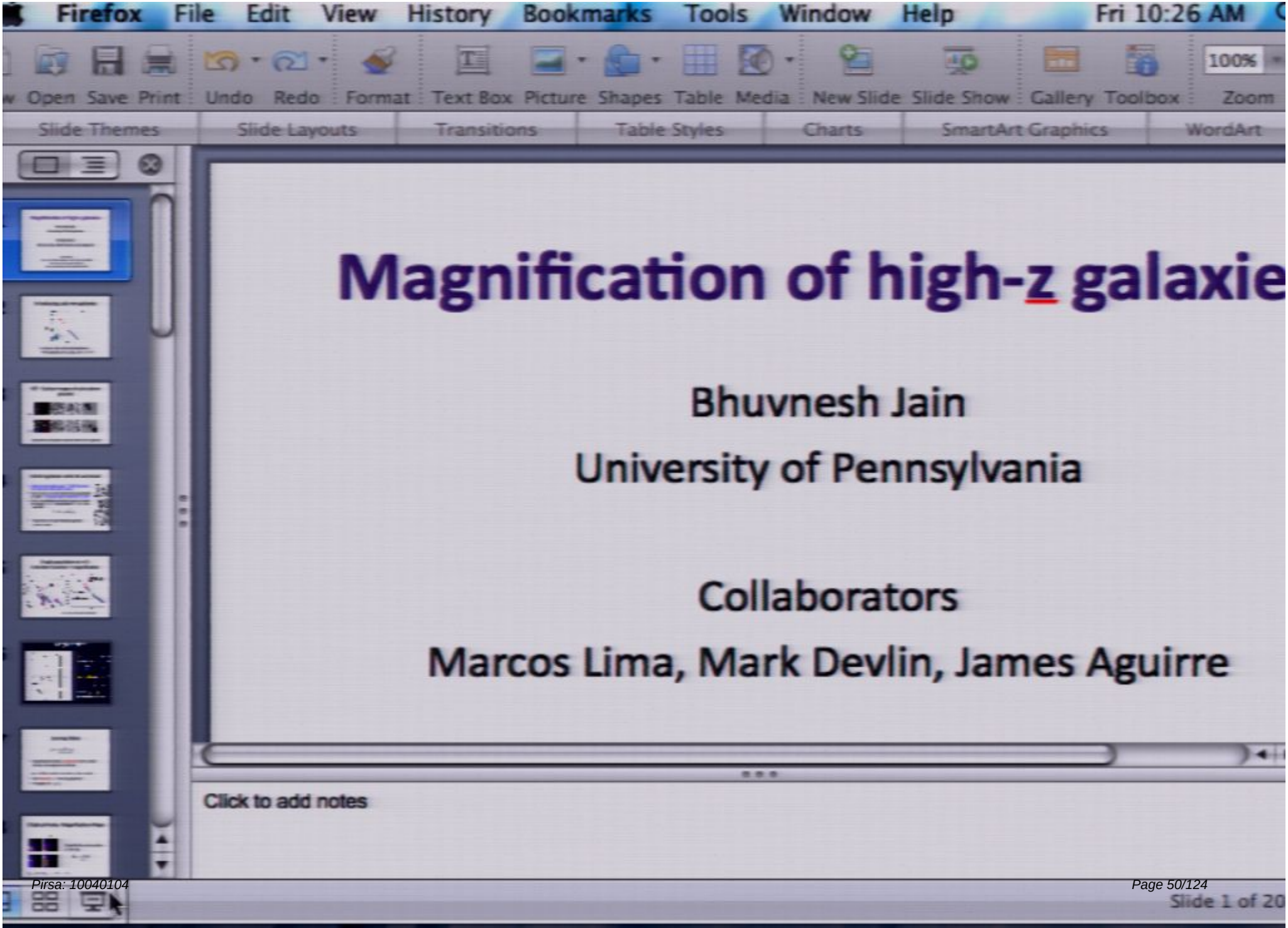
Click to add notes
Slide 1 of 20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Open Save Print Undo Redo Format Text Box Picture Shapes Table Media New Slide Slide Show Gallery Toolbox 100% Zoom
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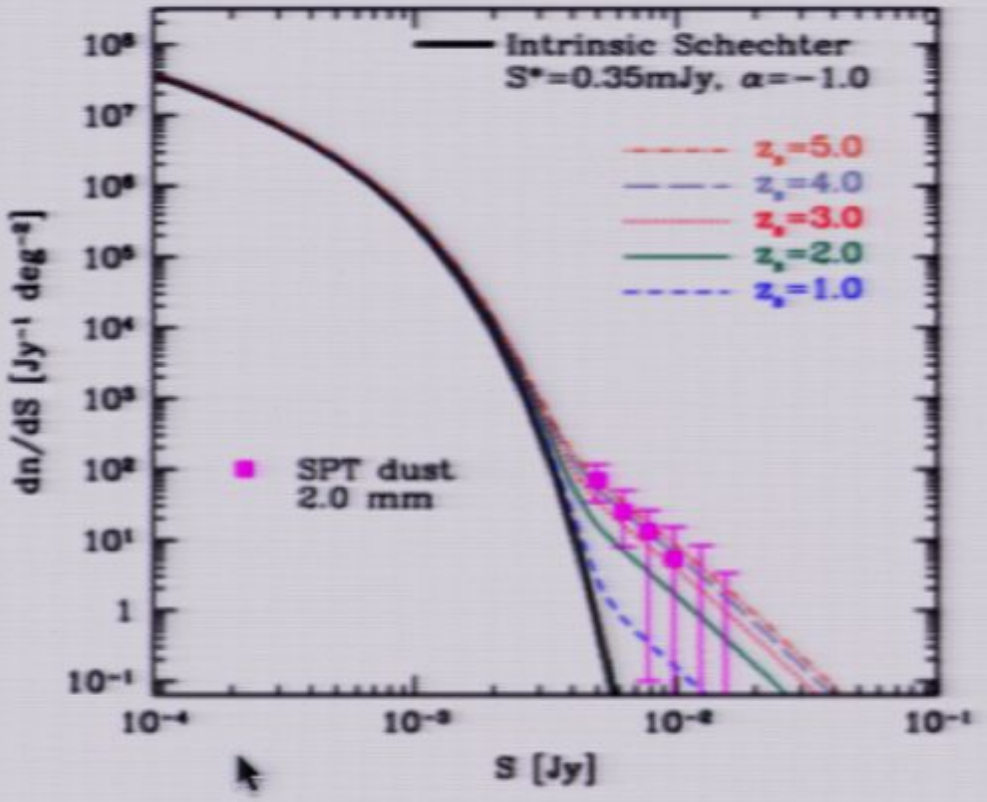

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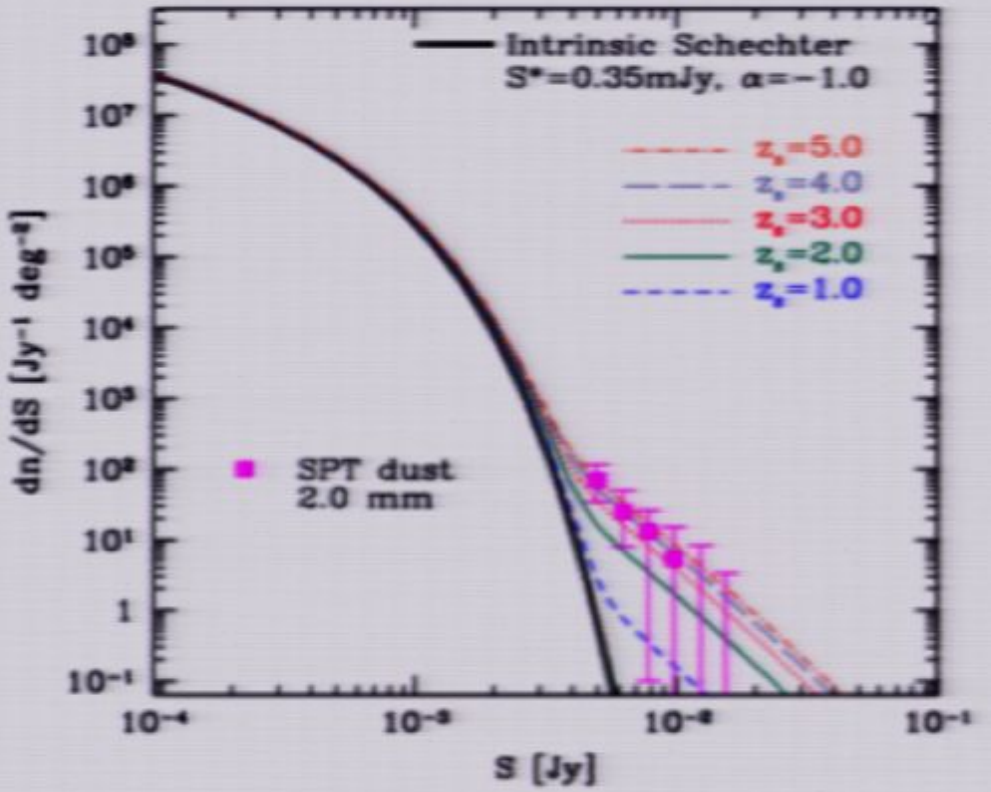

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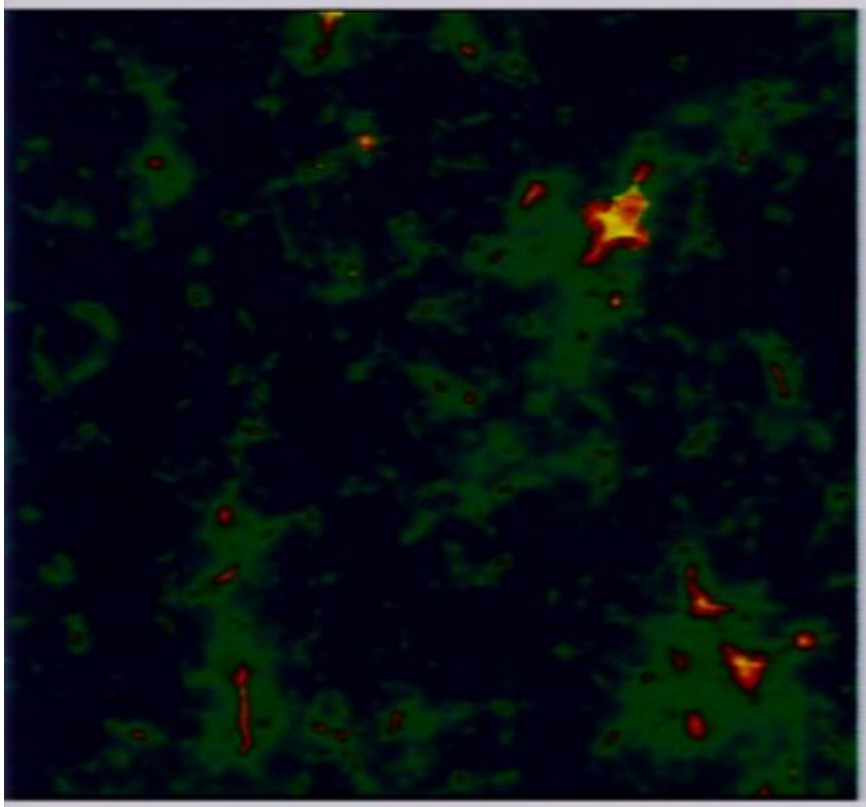

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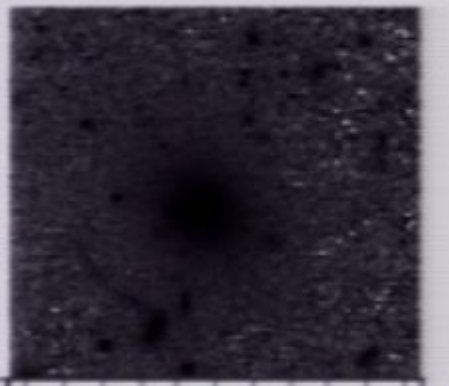

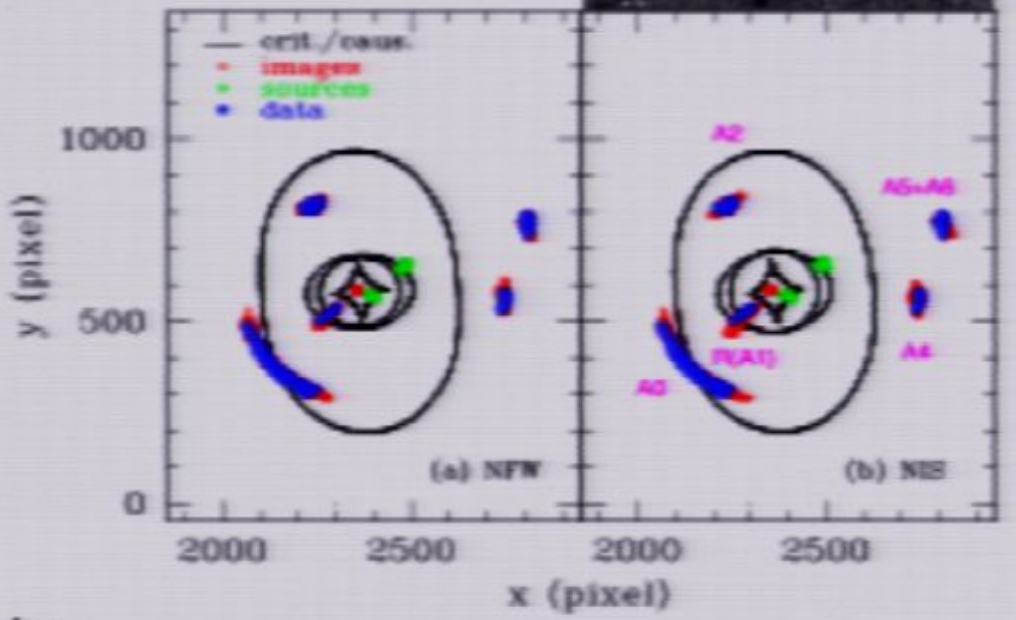

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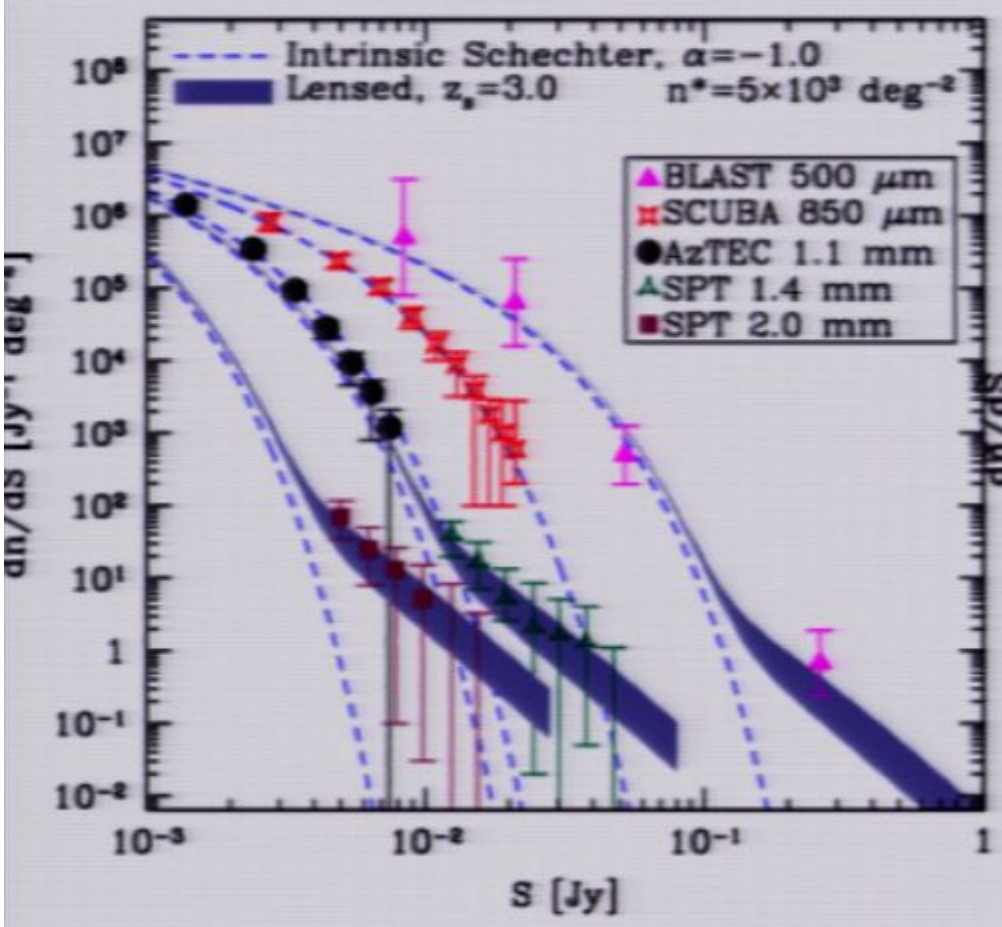

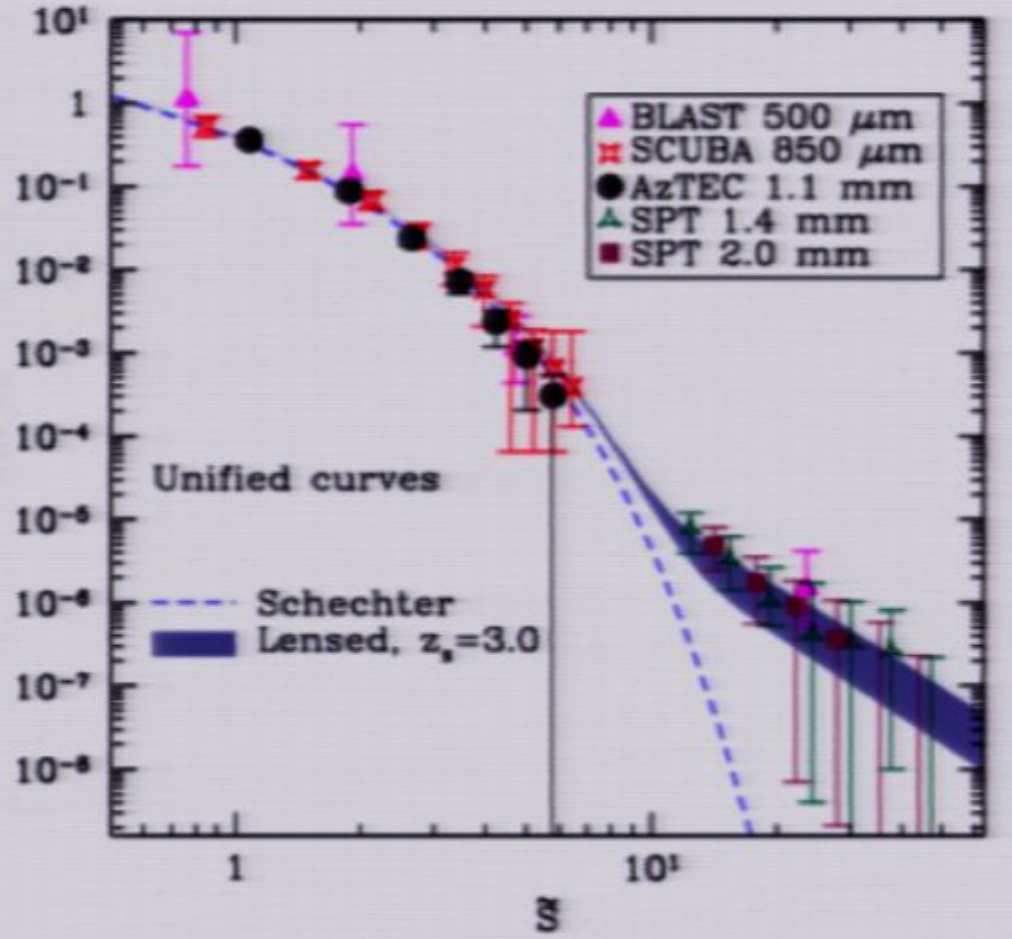

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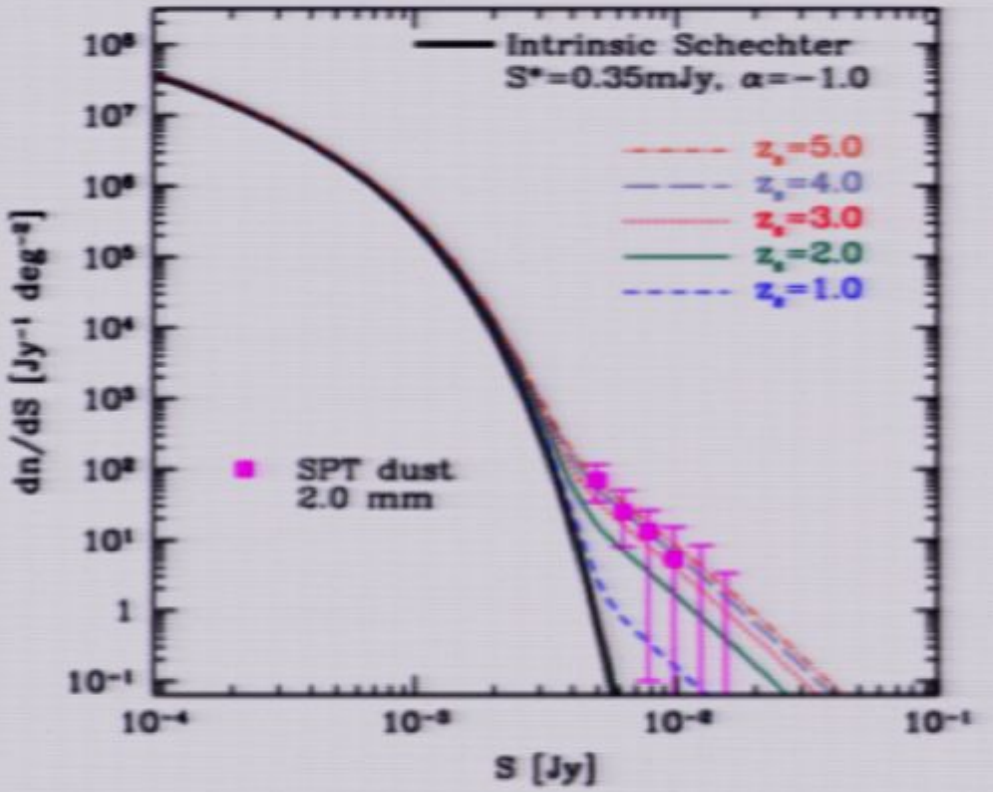

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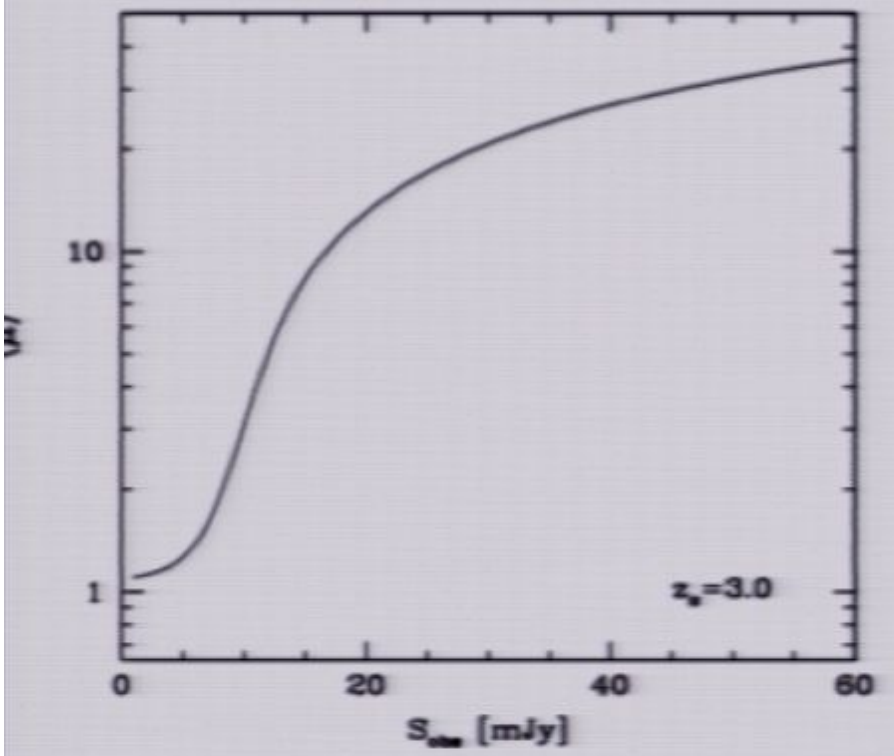

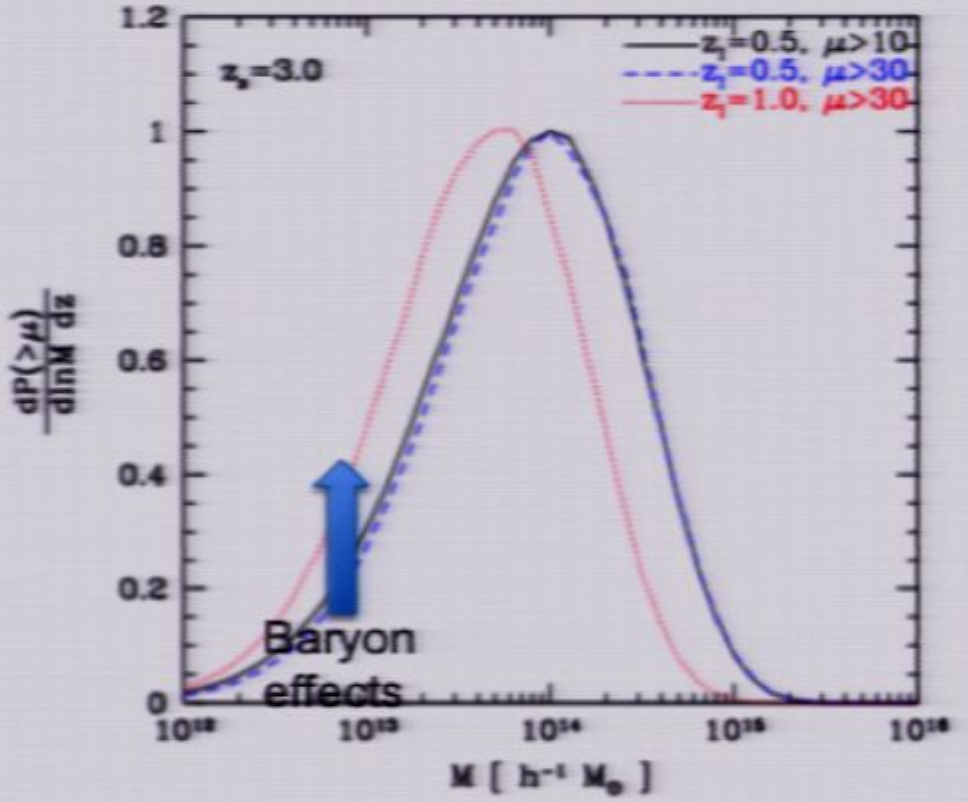

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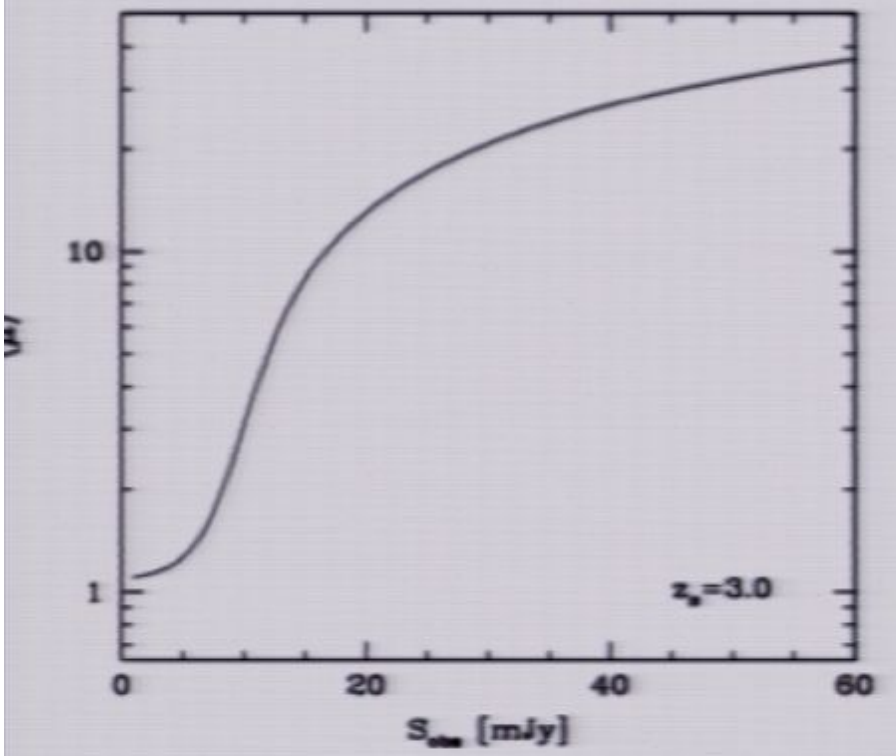

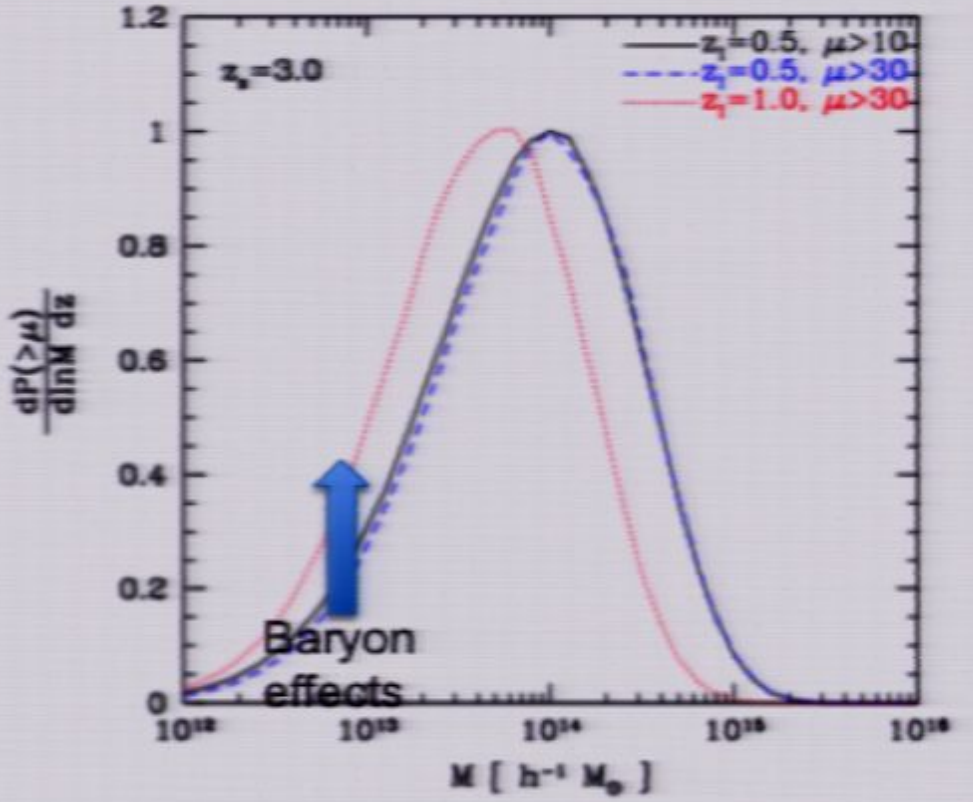

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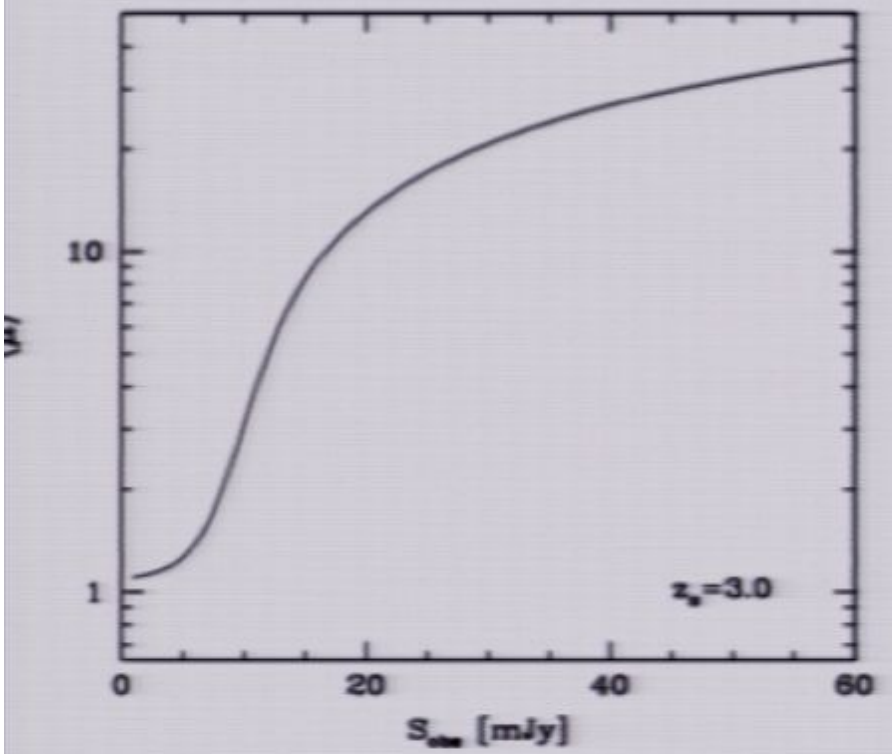

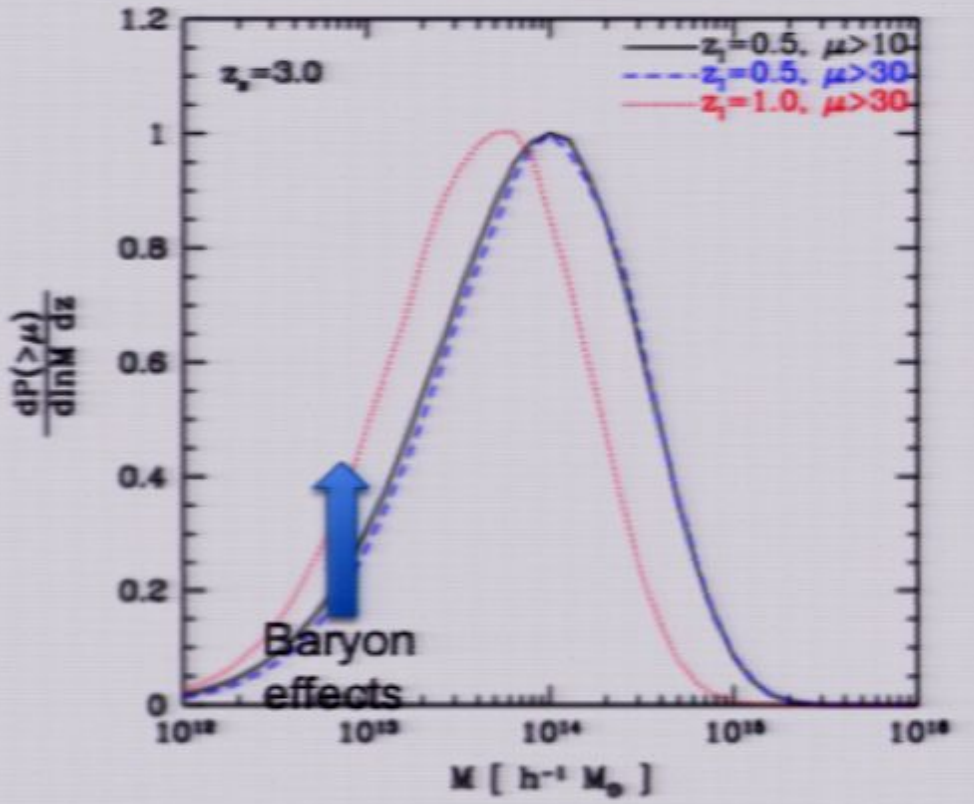

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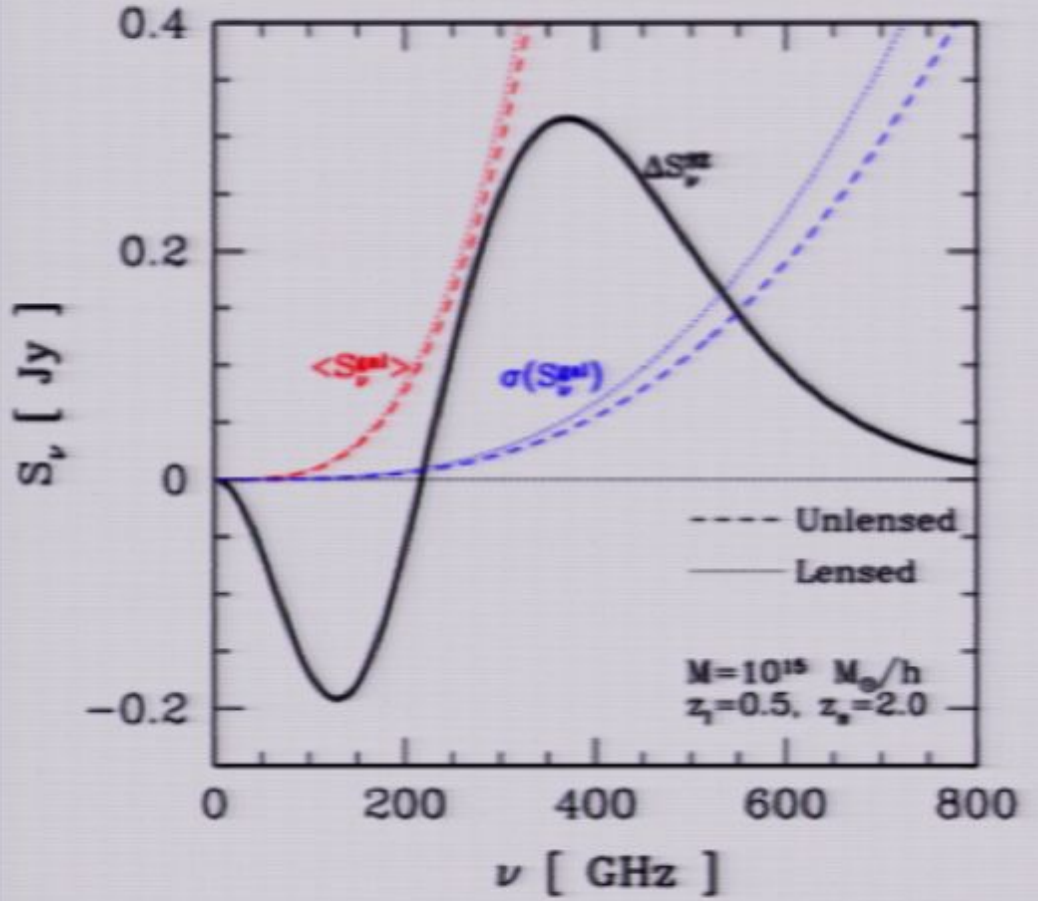

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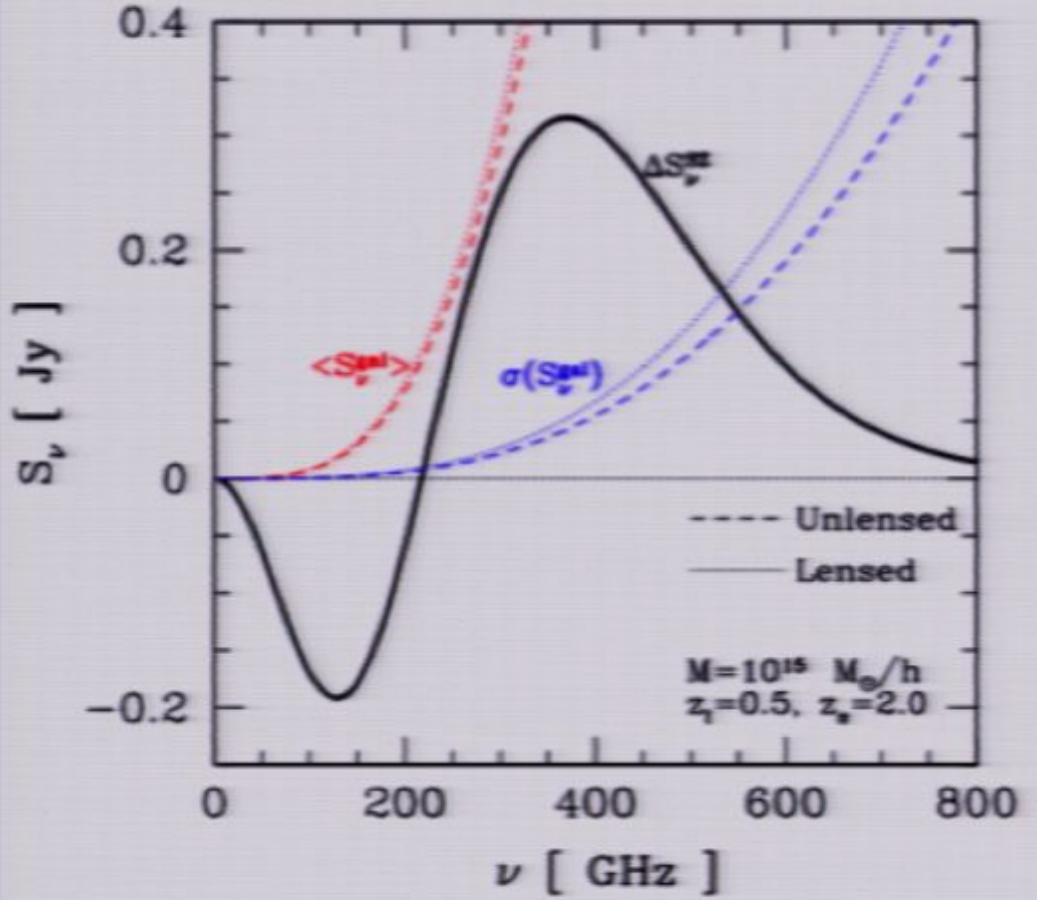

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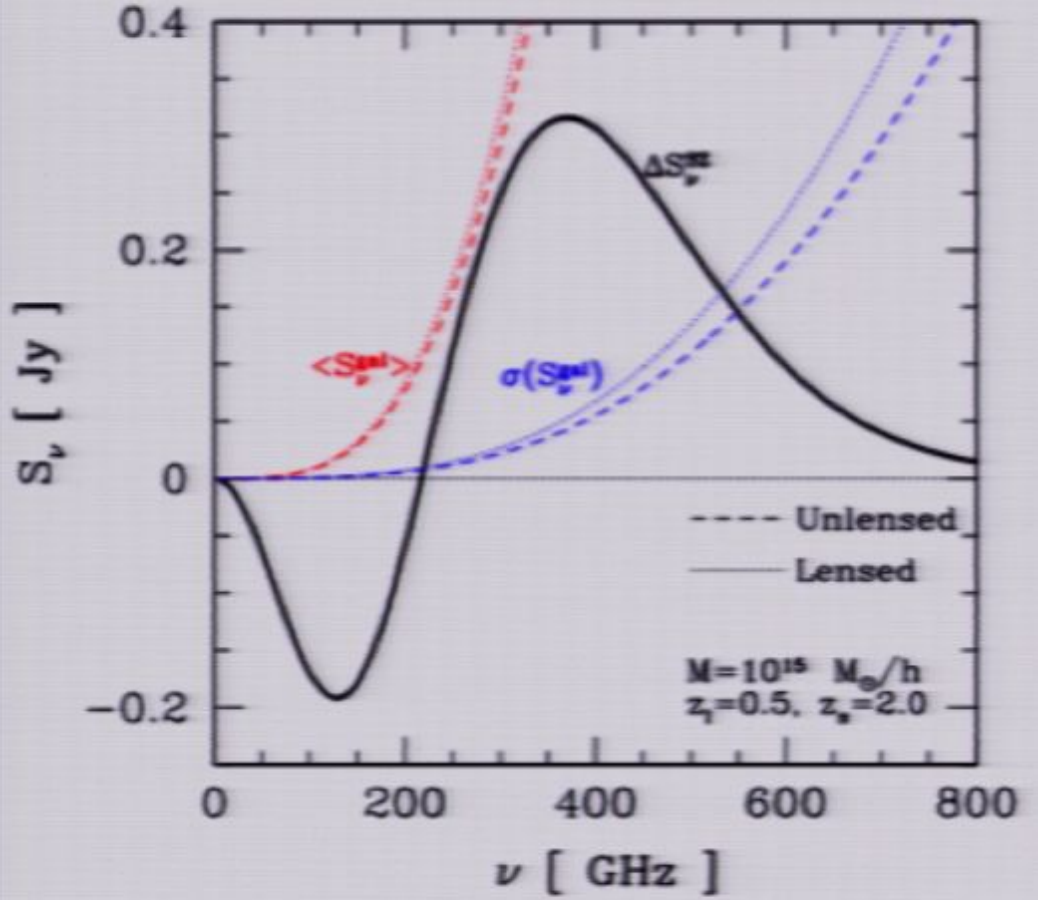

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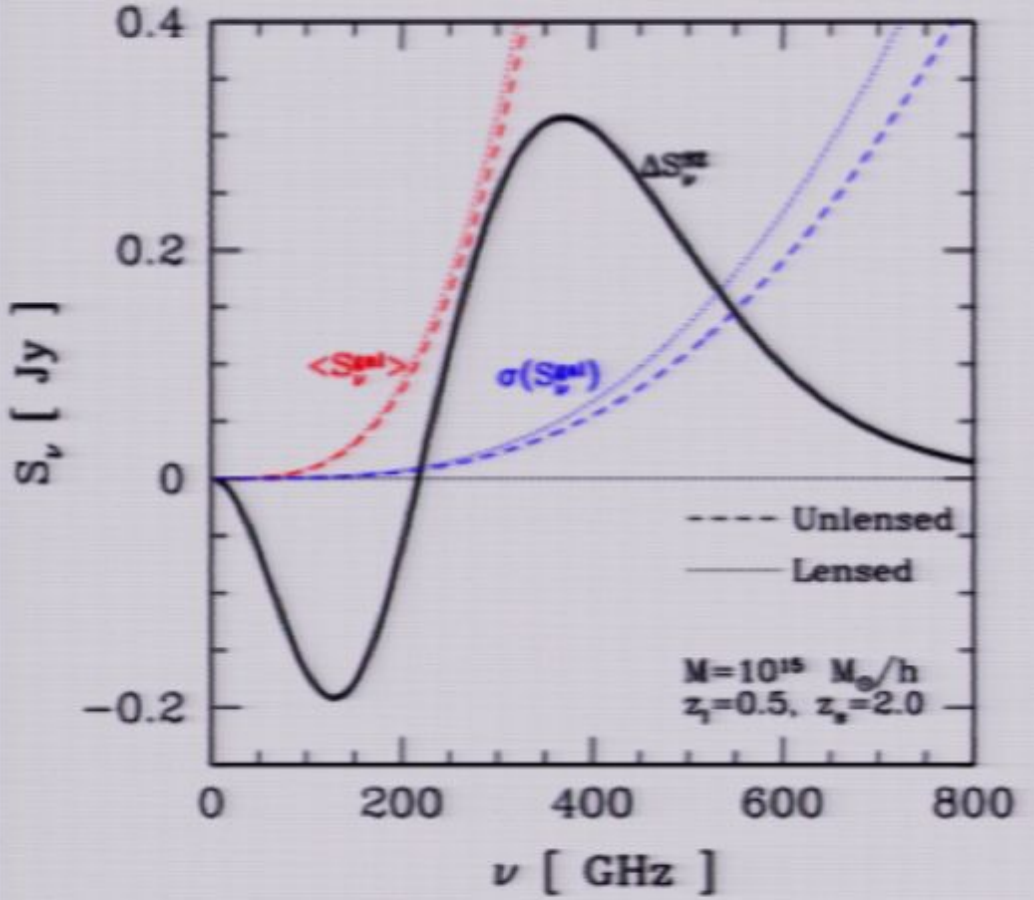

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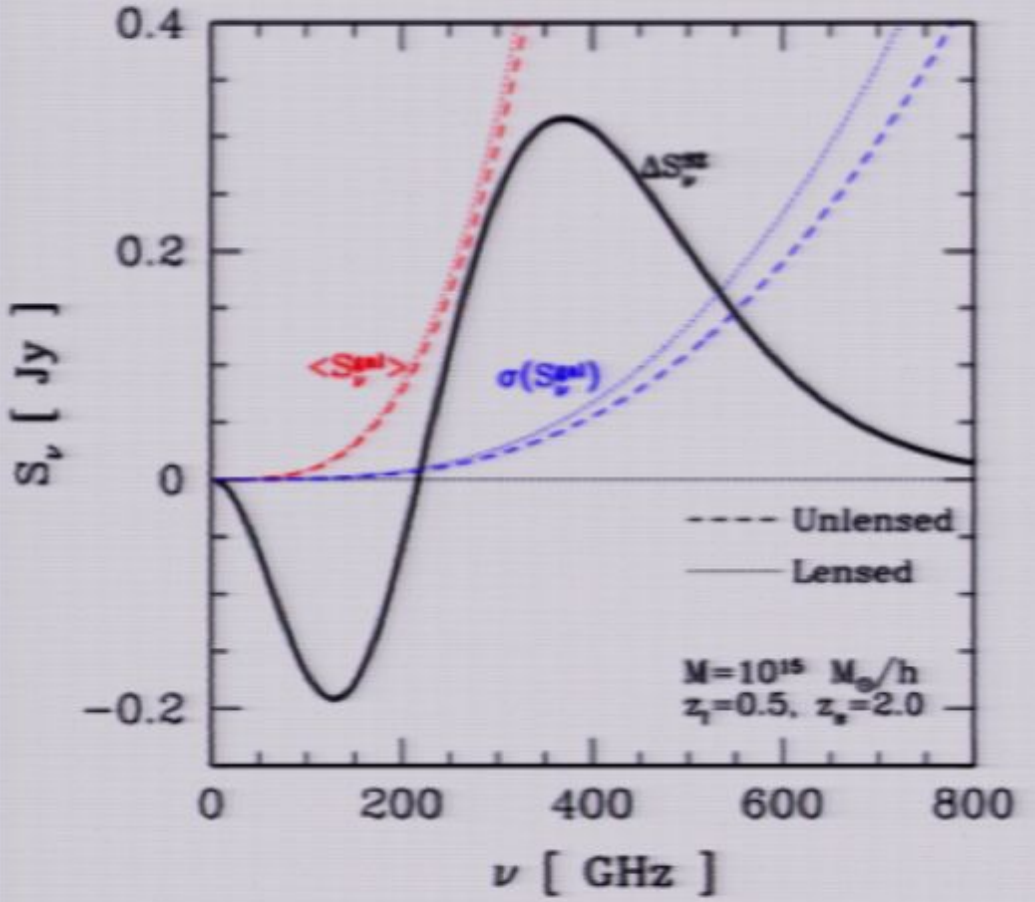

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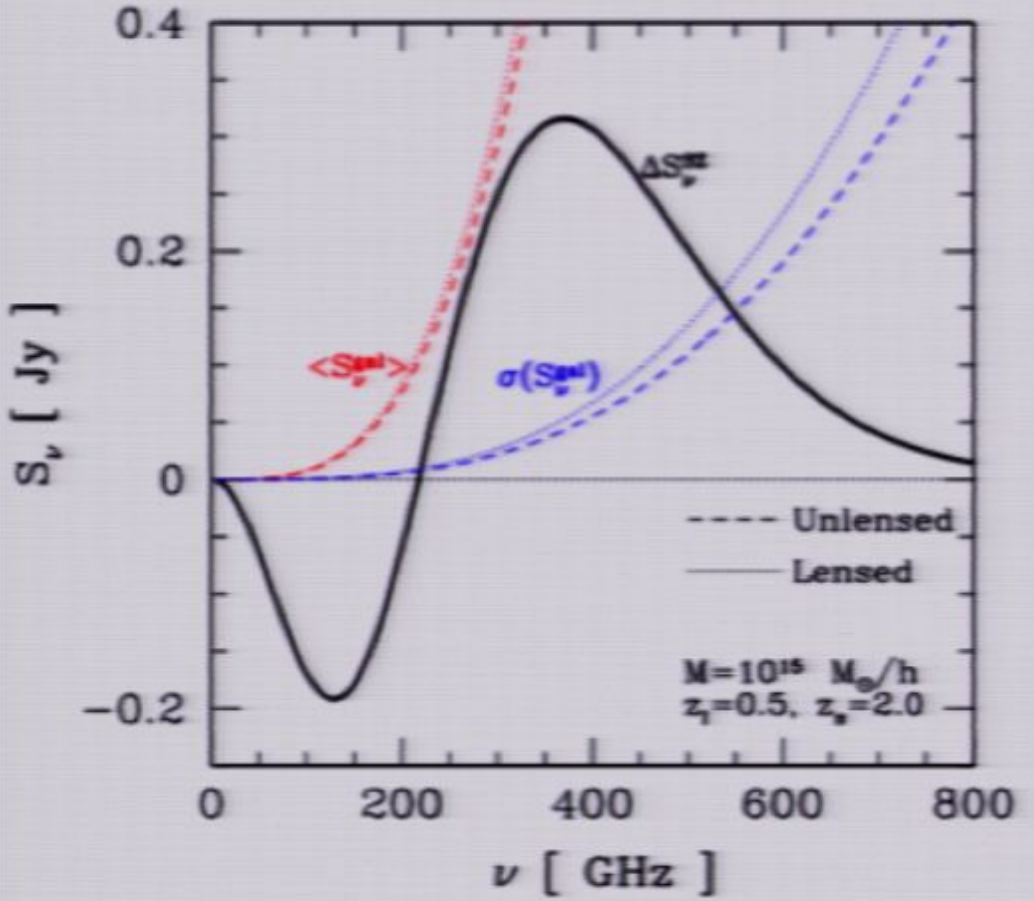

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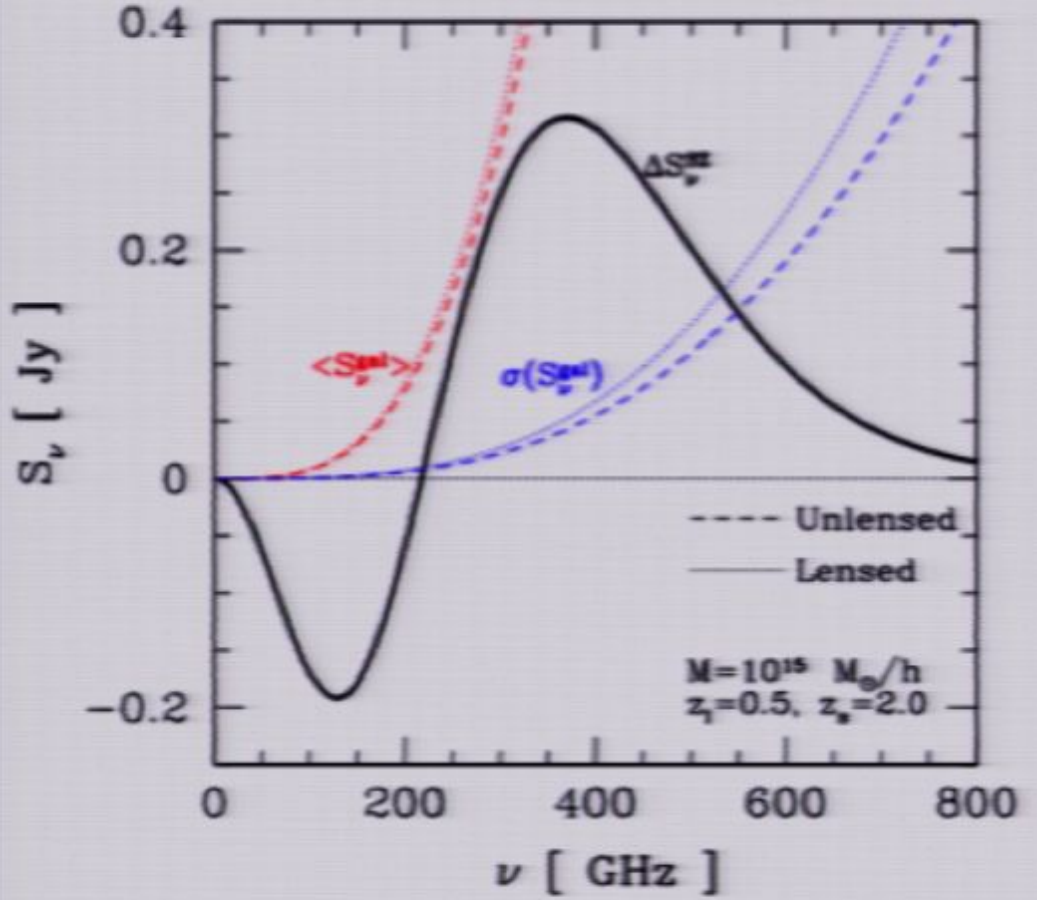

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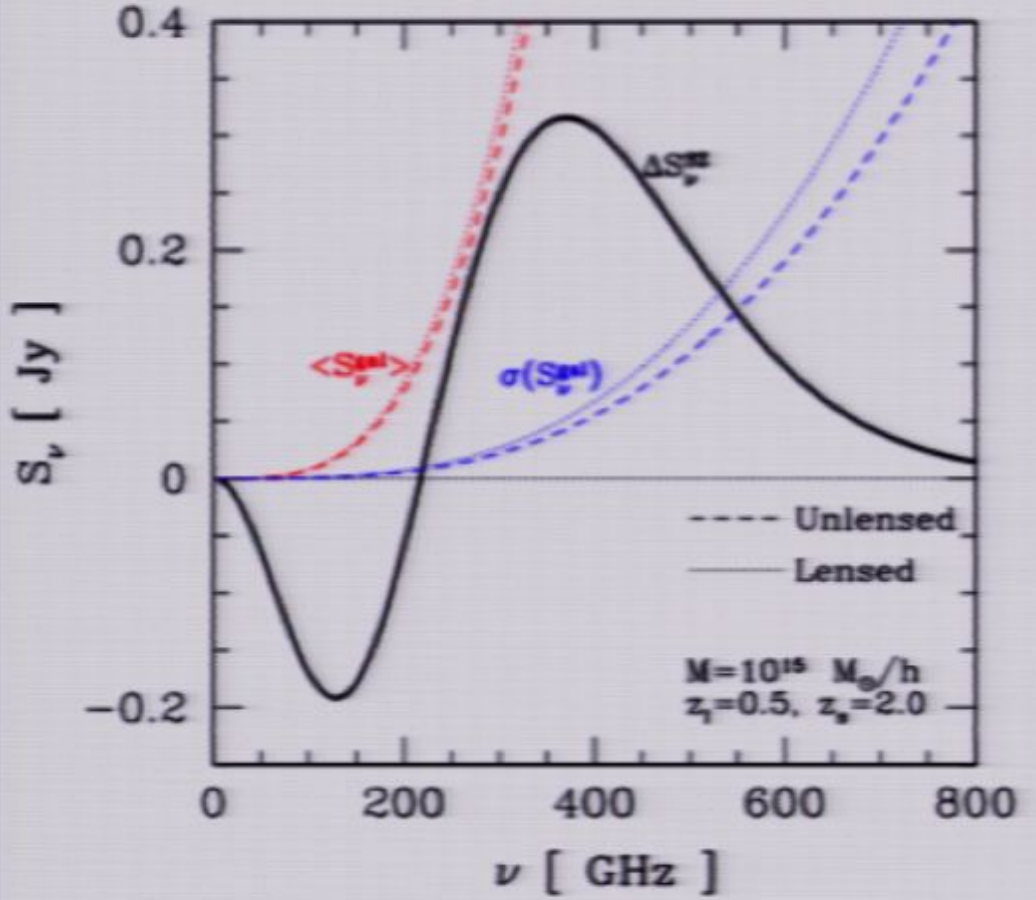

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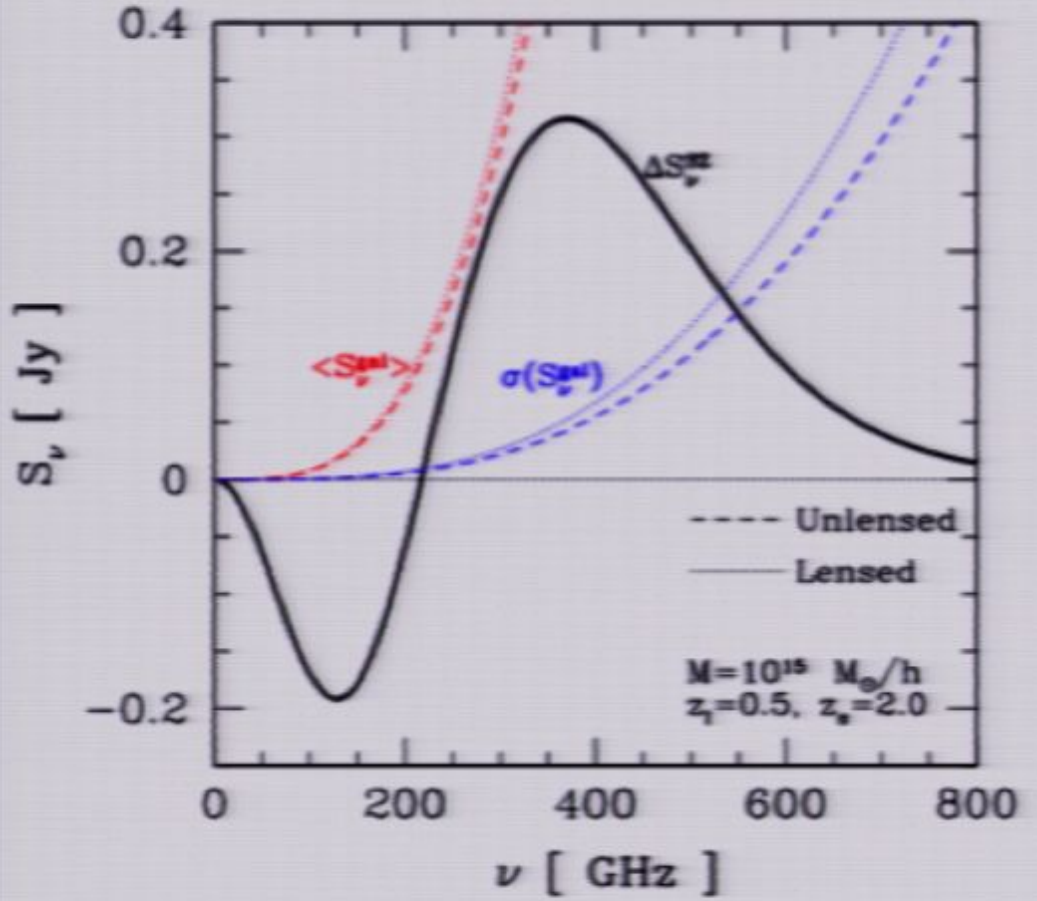

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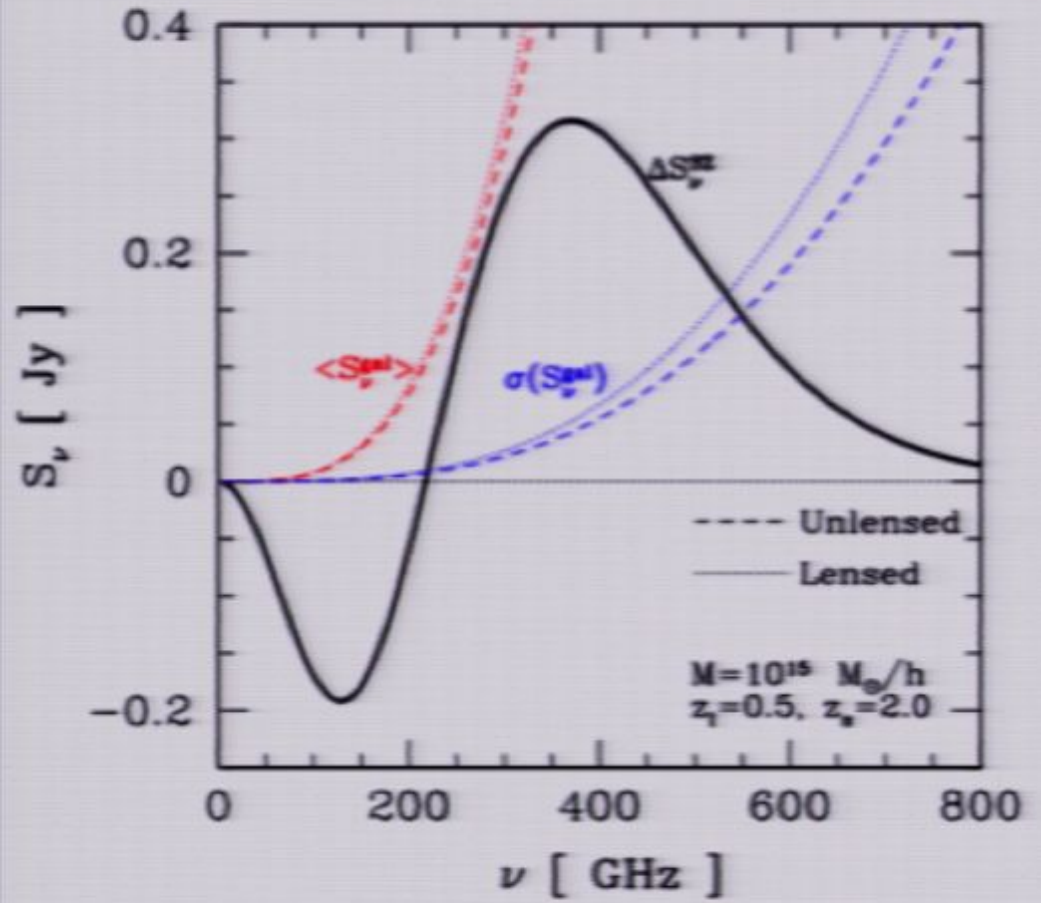

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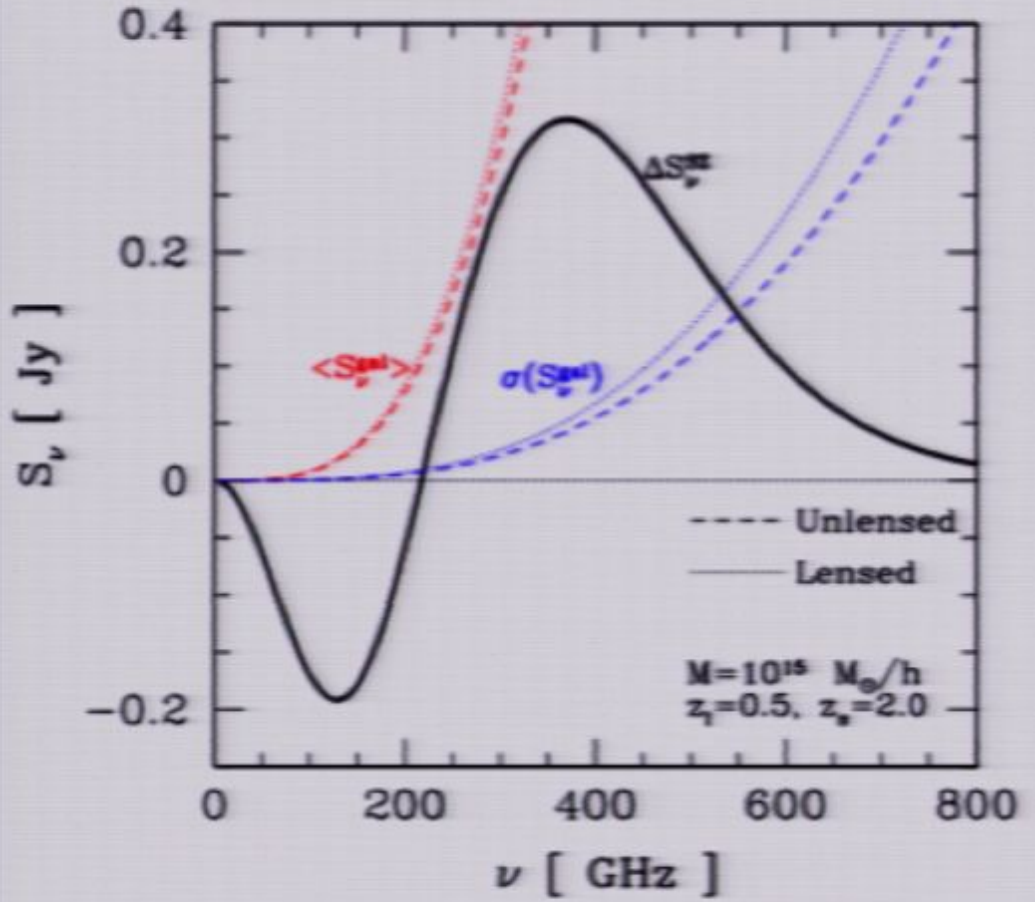

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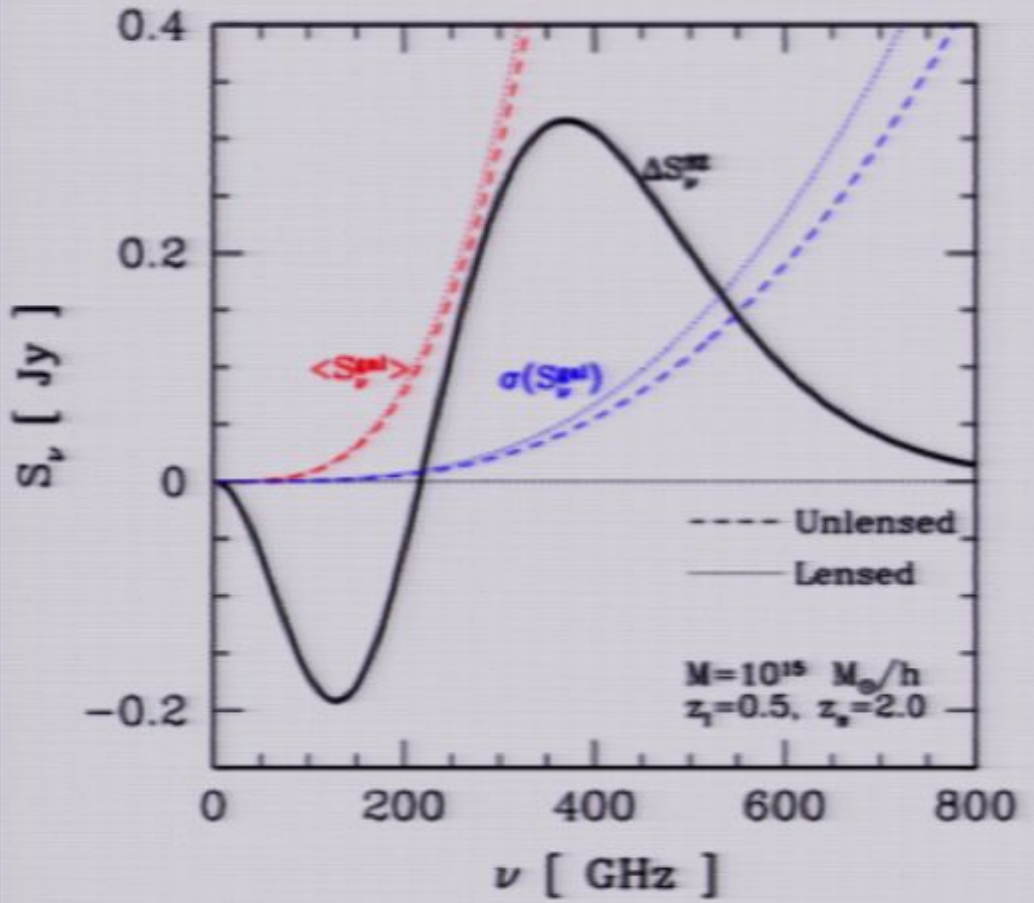

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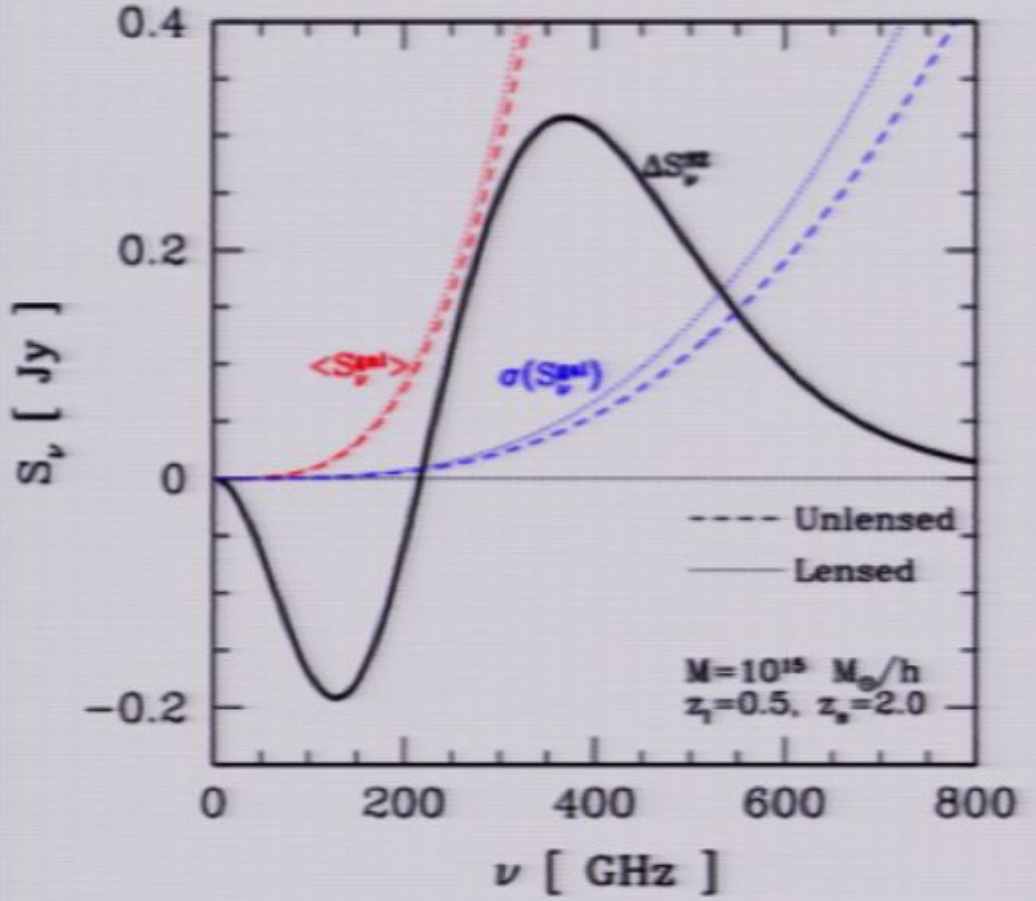

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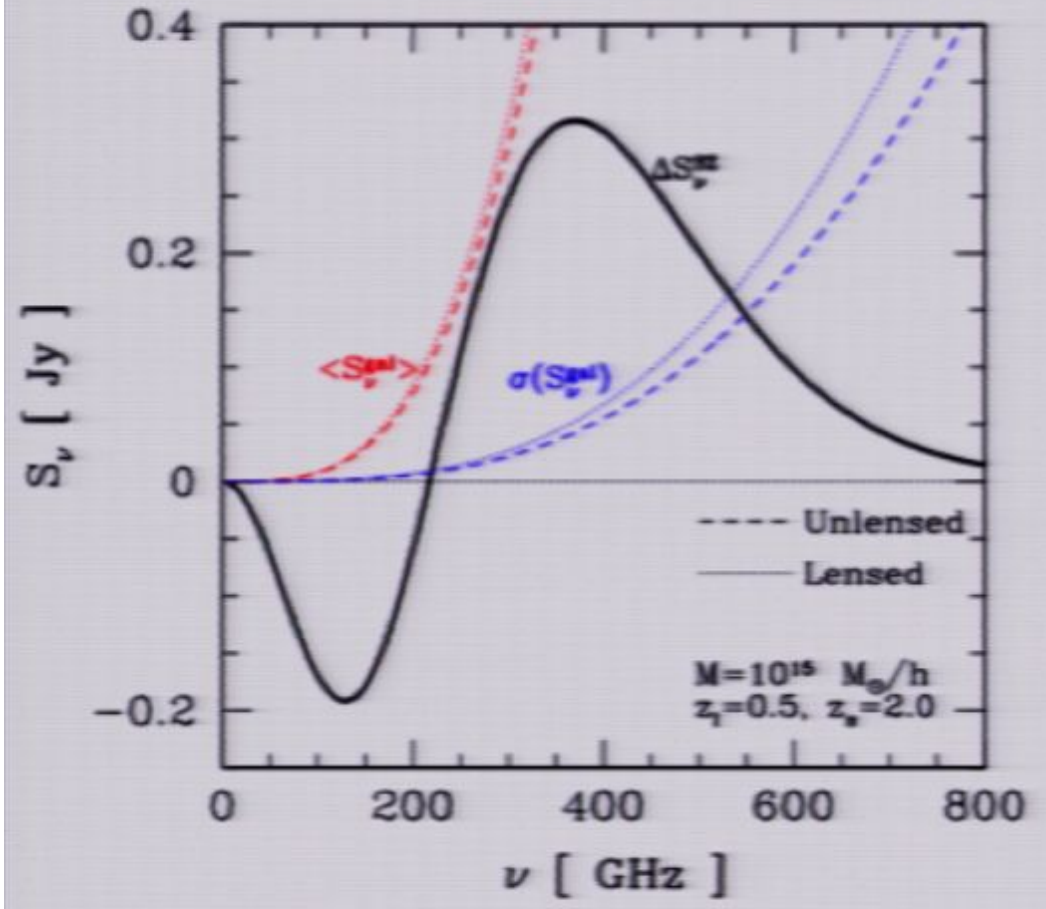

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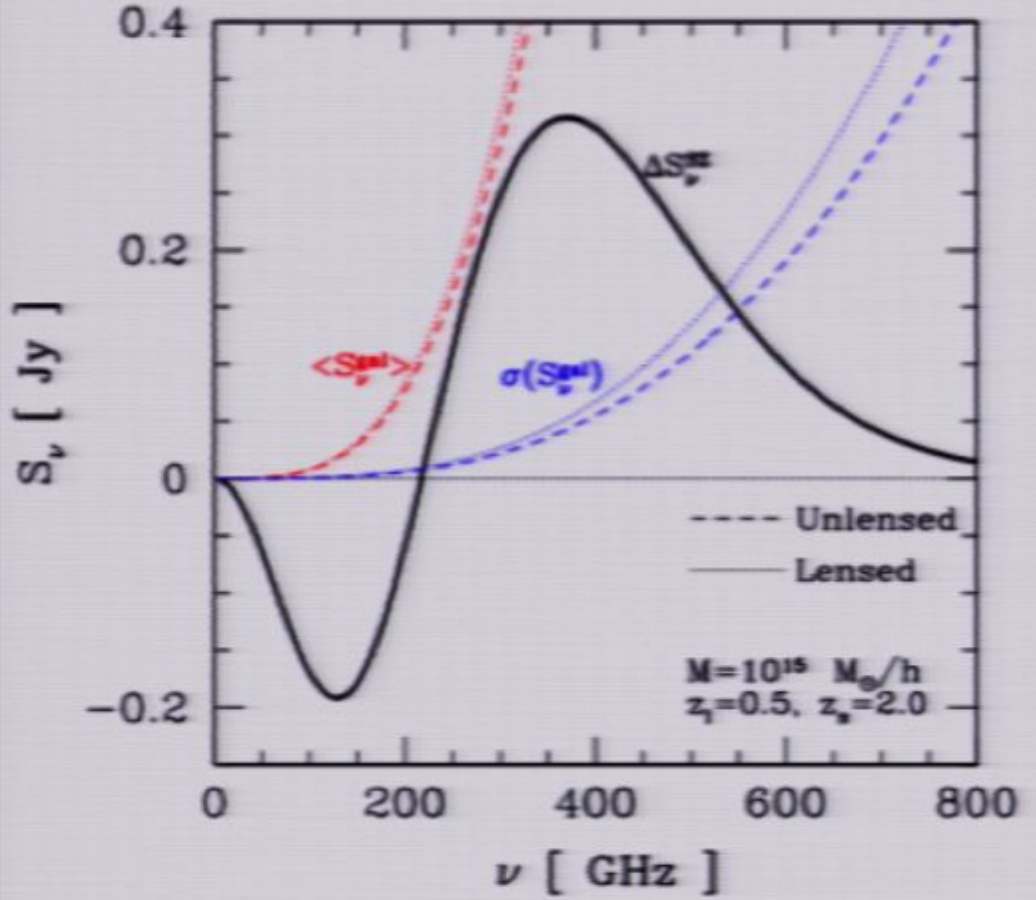

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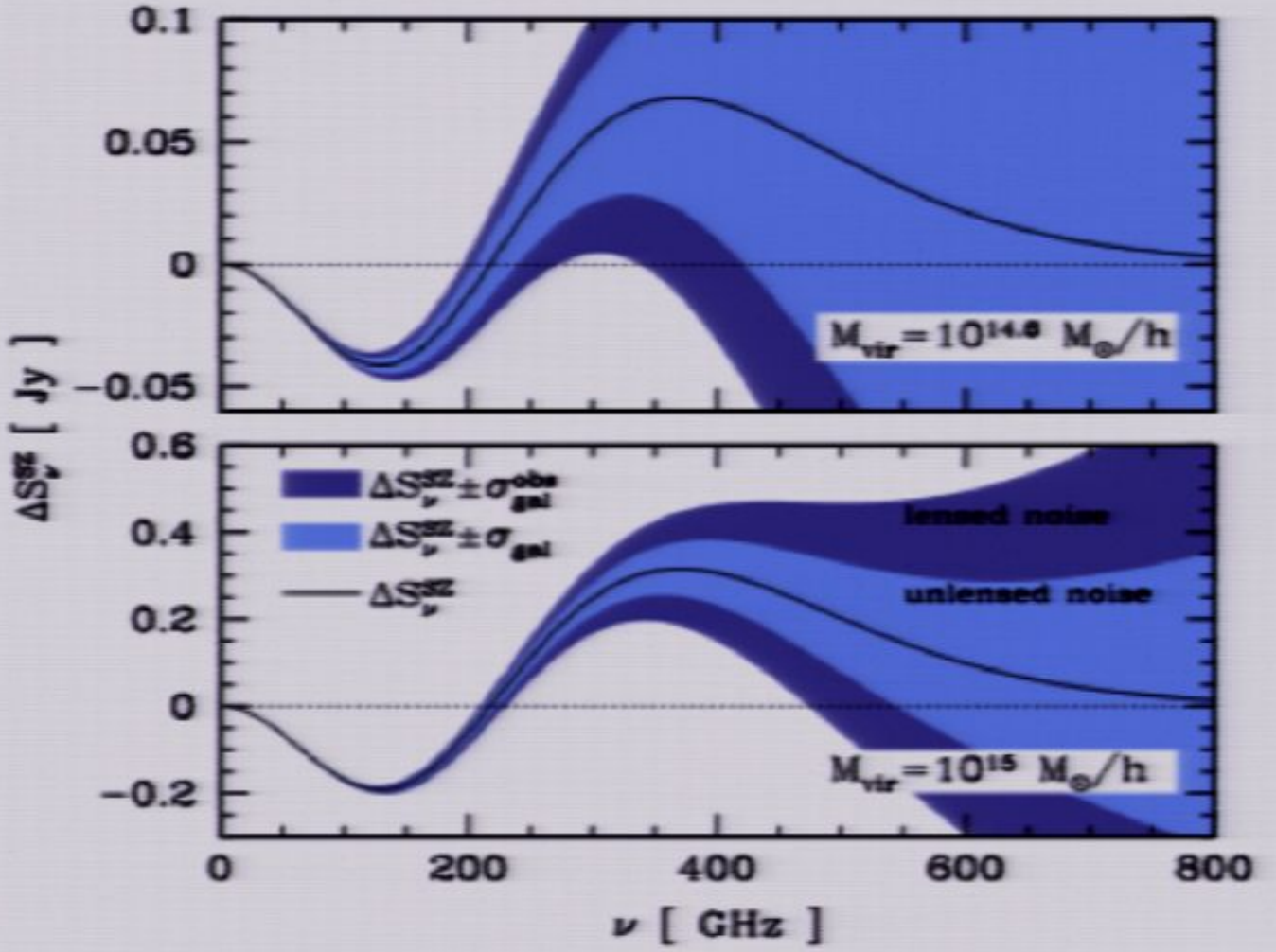

Frequency dependent source of scatter in SZ clusters

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- With magnification by galaxy groups and clusters, we explain submm observations with a single population at z>2
- New high resolution observations will solve or add to the puzzles about submm galaxies

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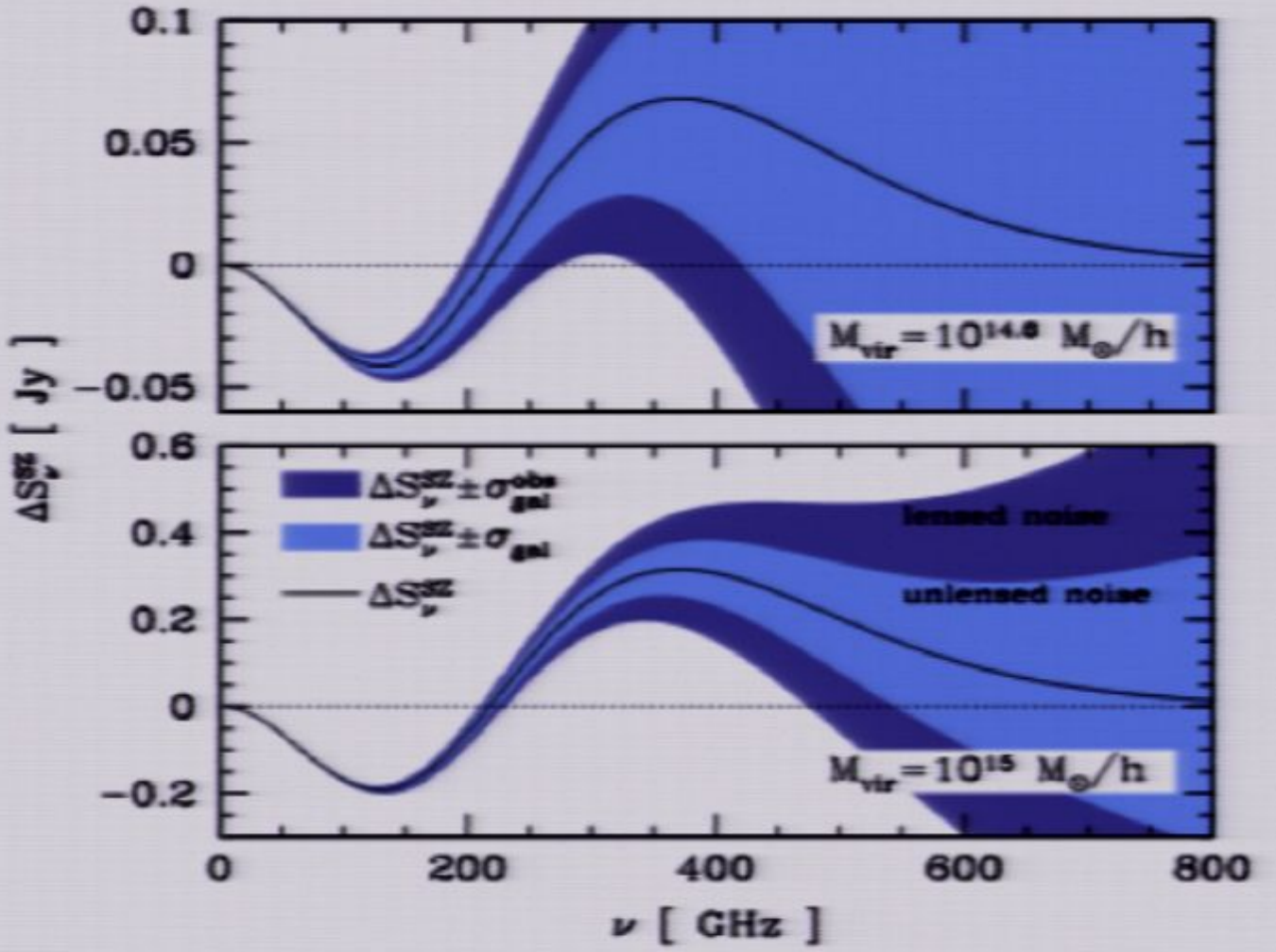

Frequency dependent source of scatter in SZ clusters

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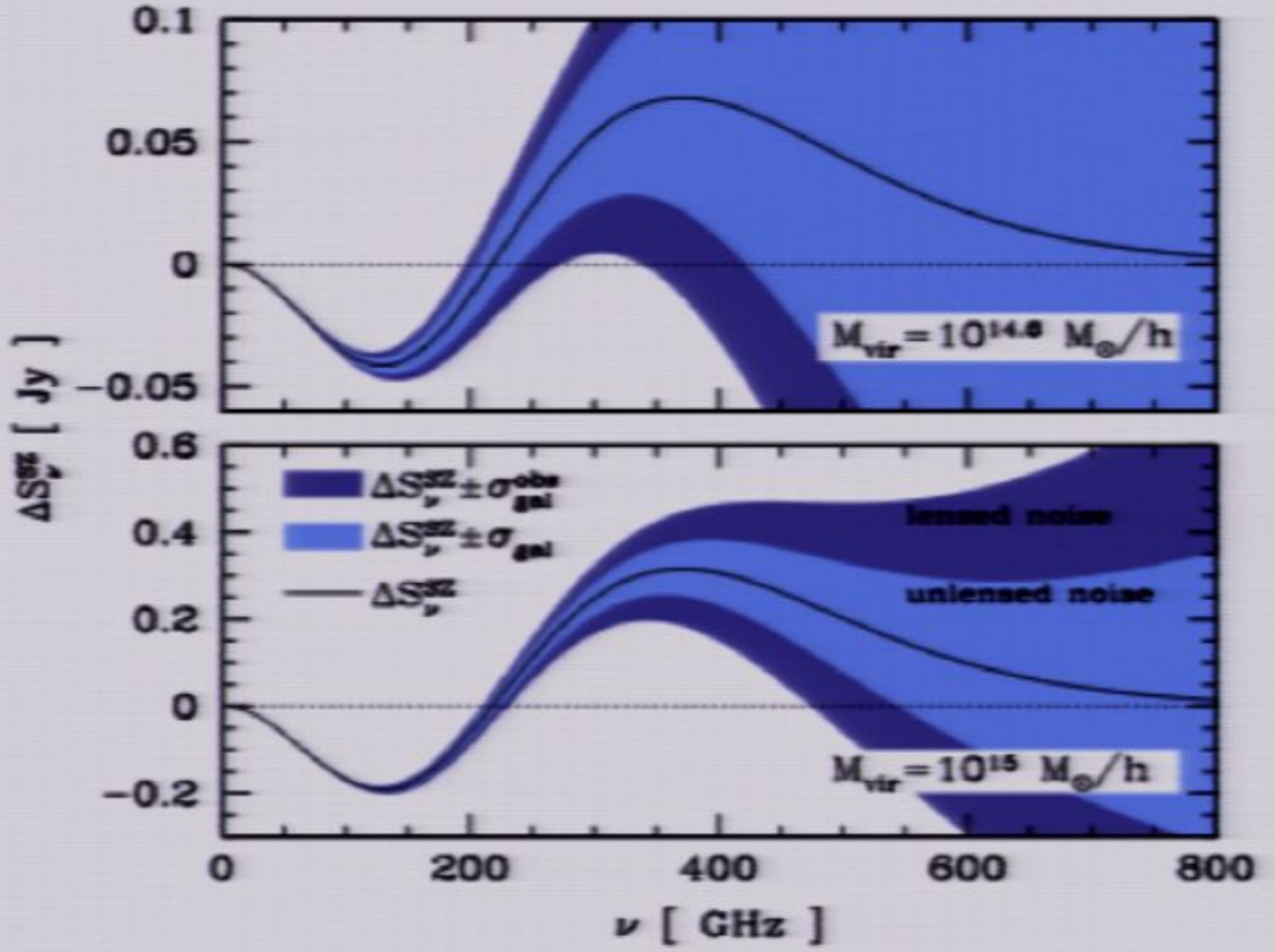

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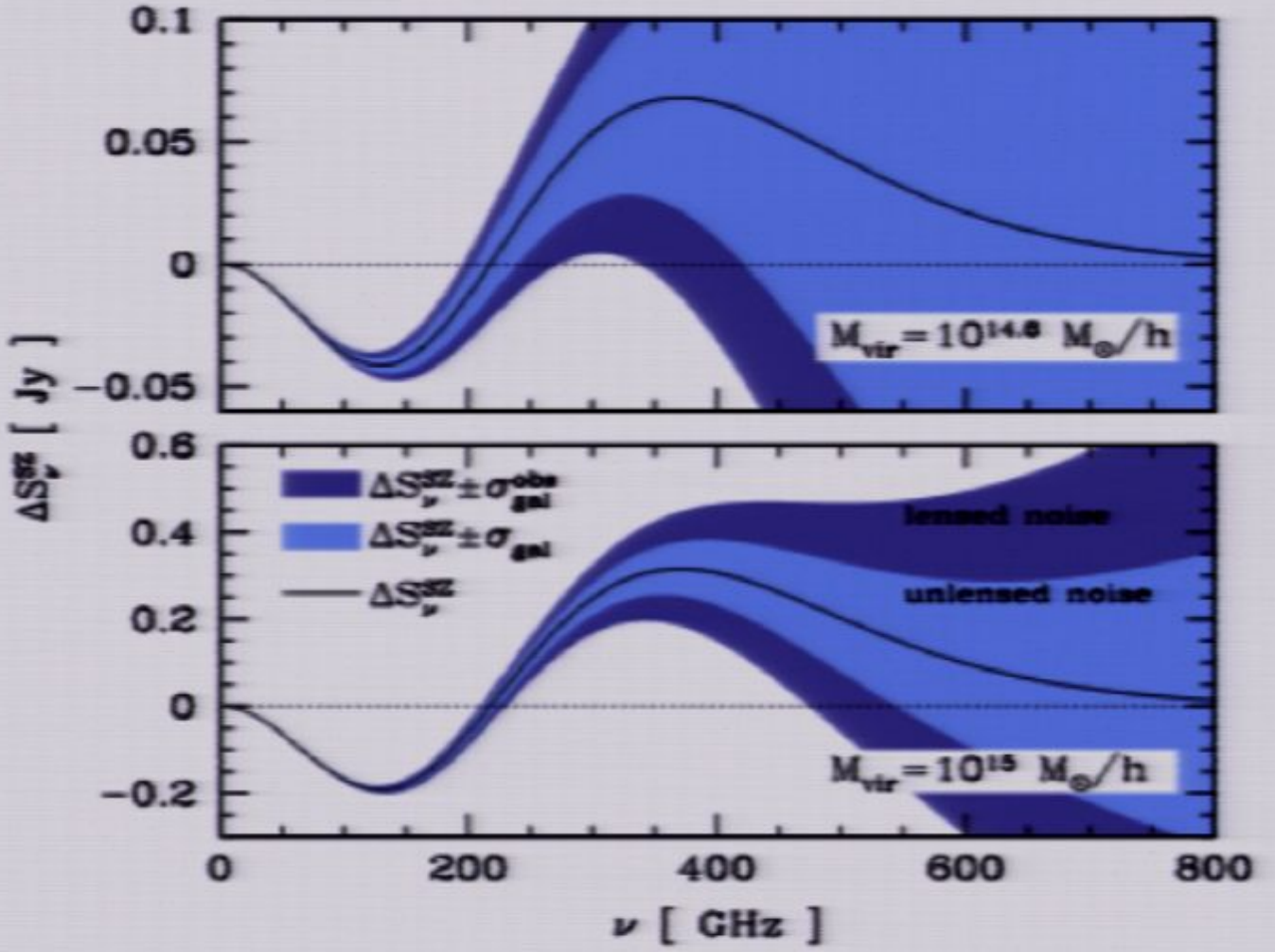

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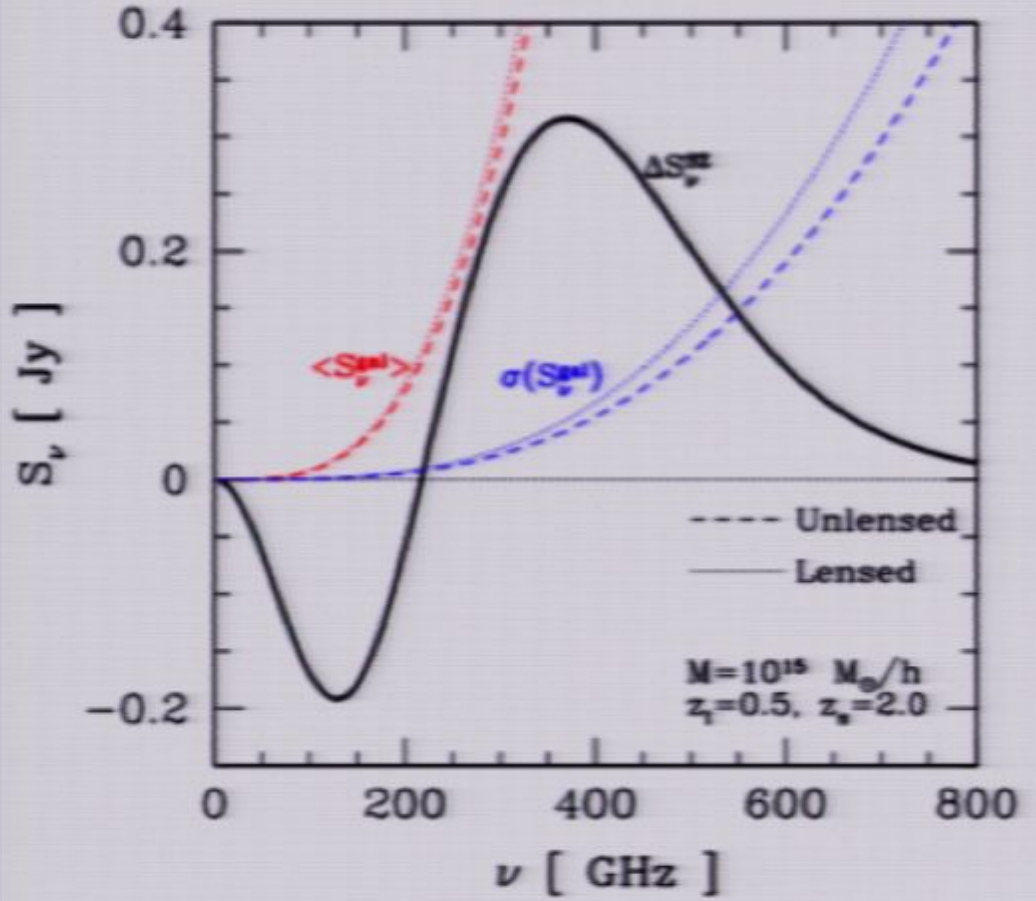

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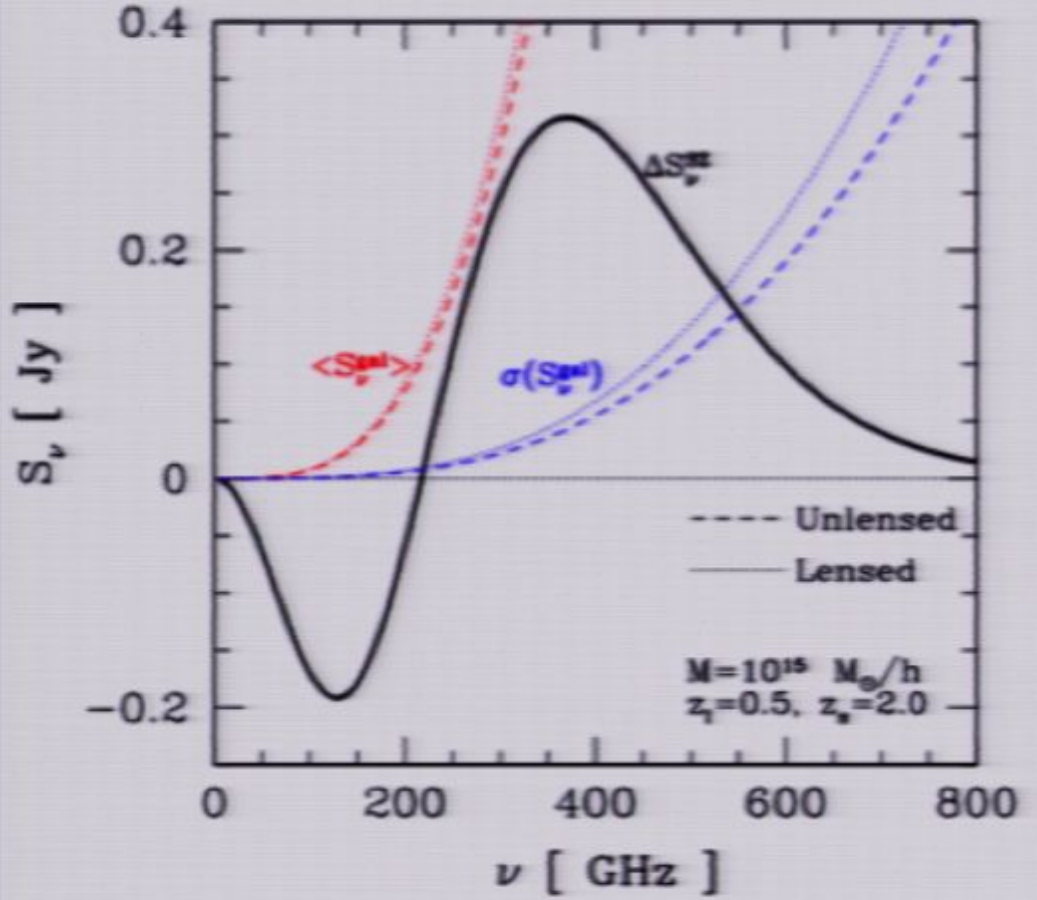

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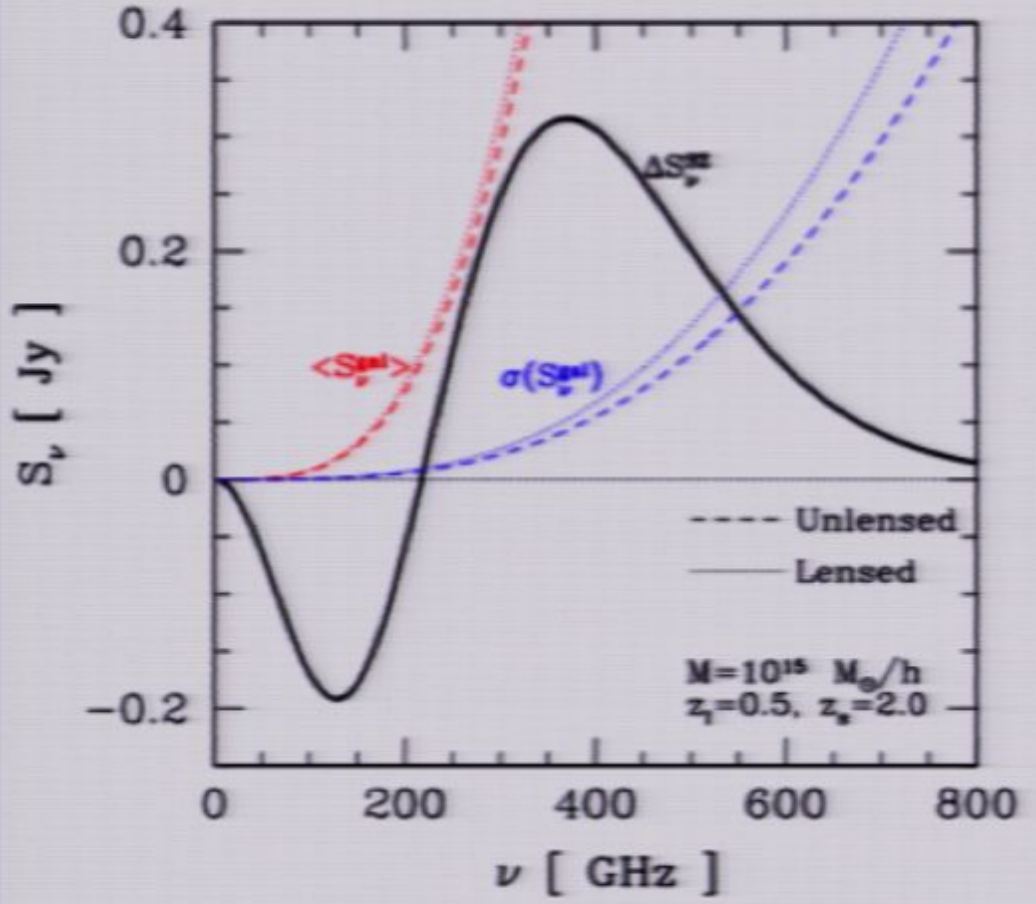

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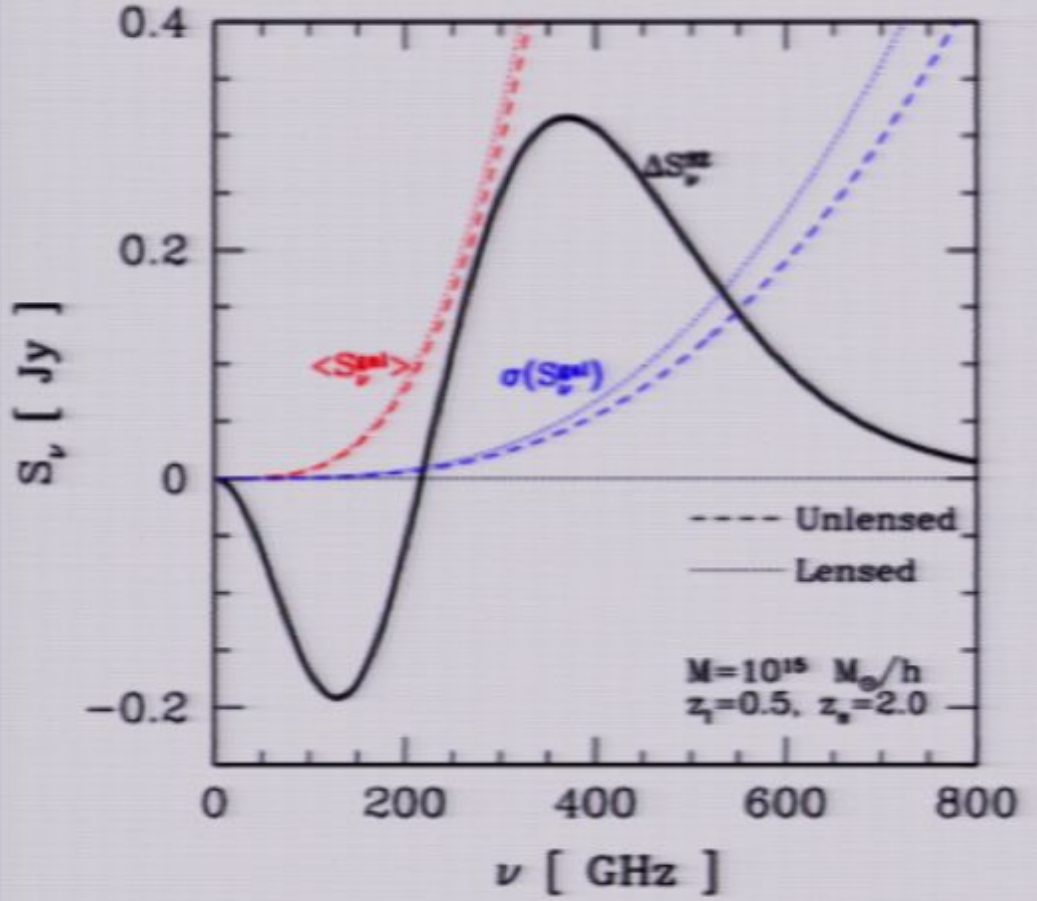

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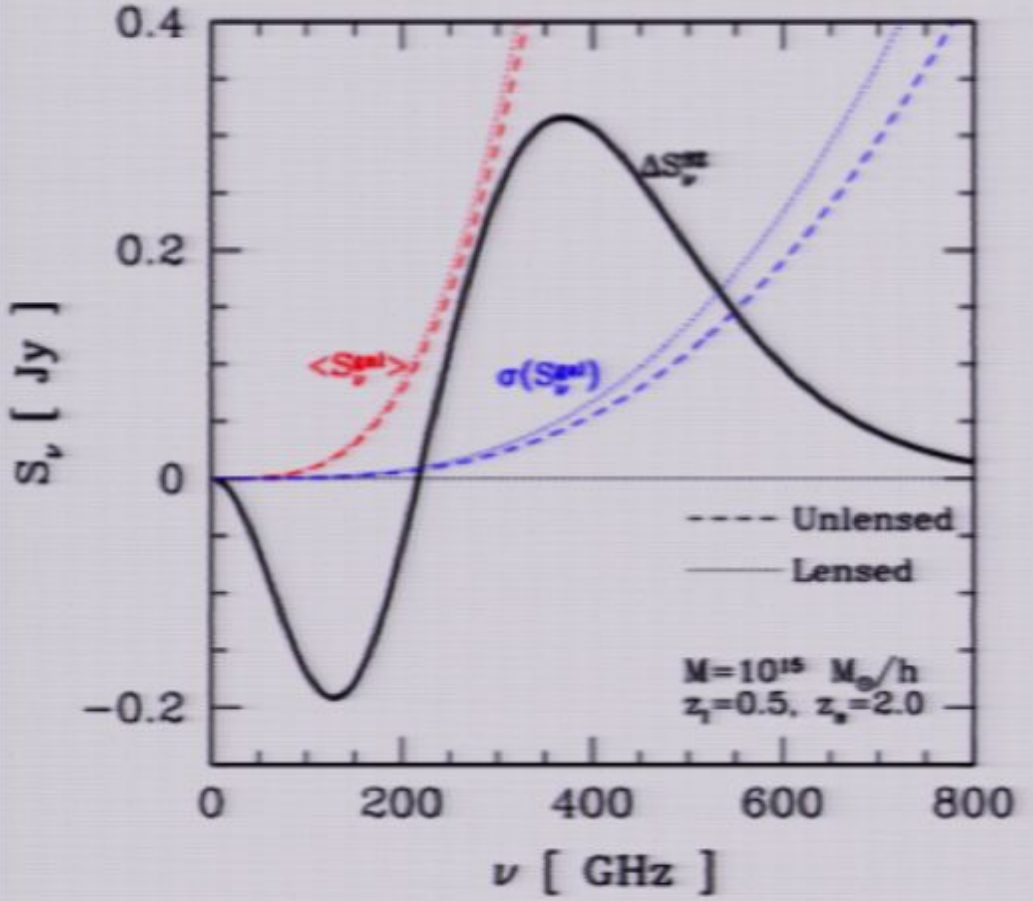

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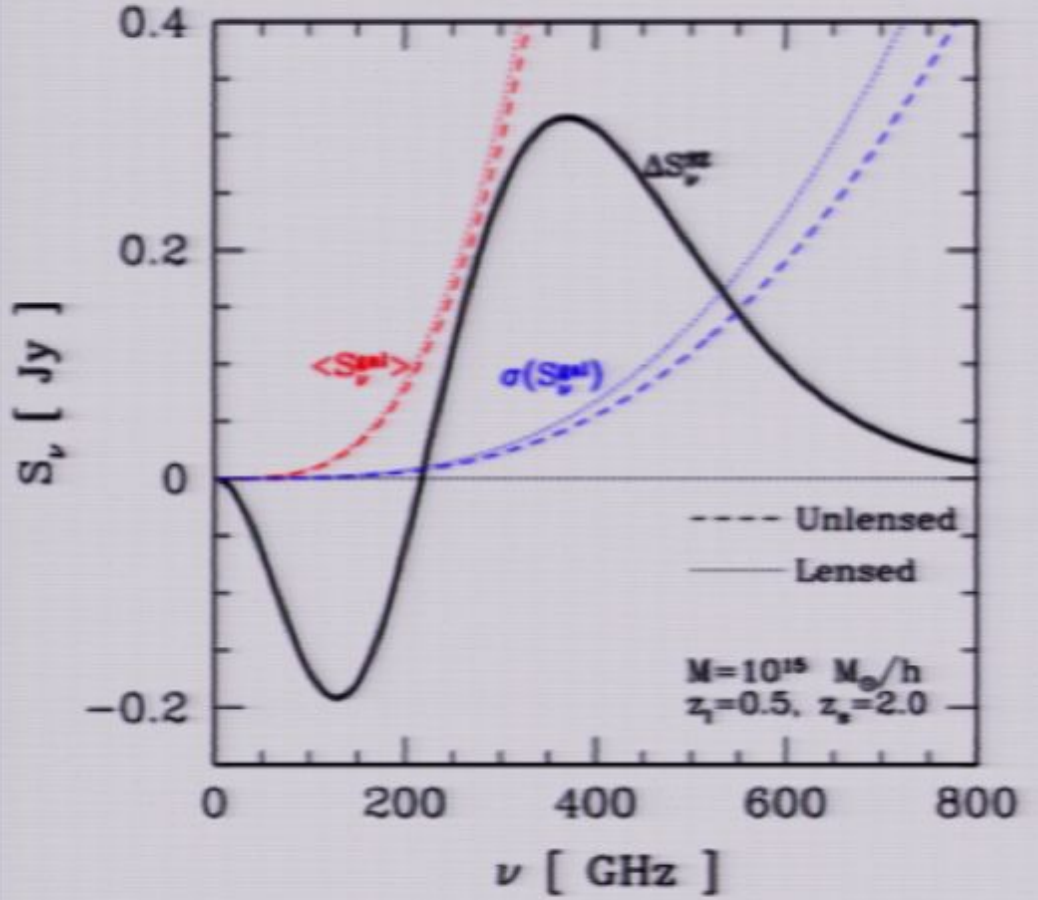

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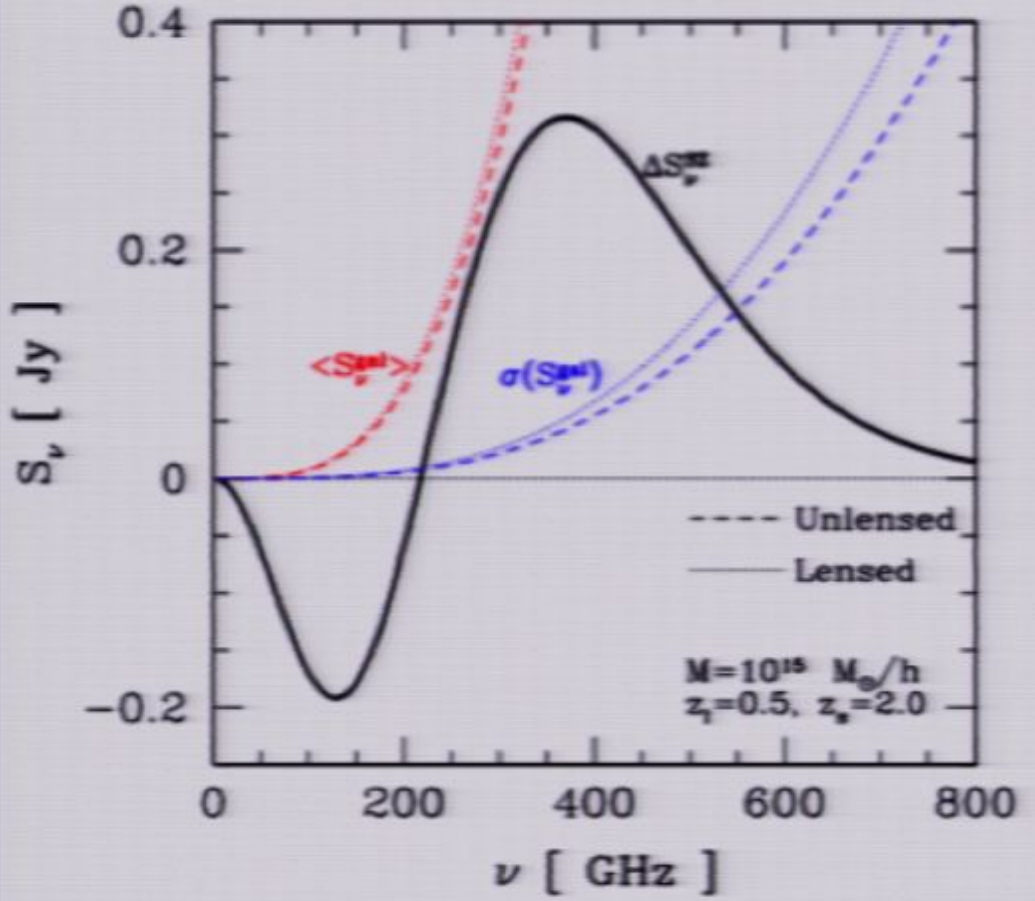

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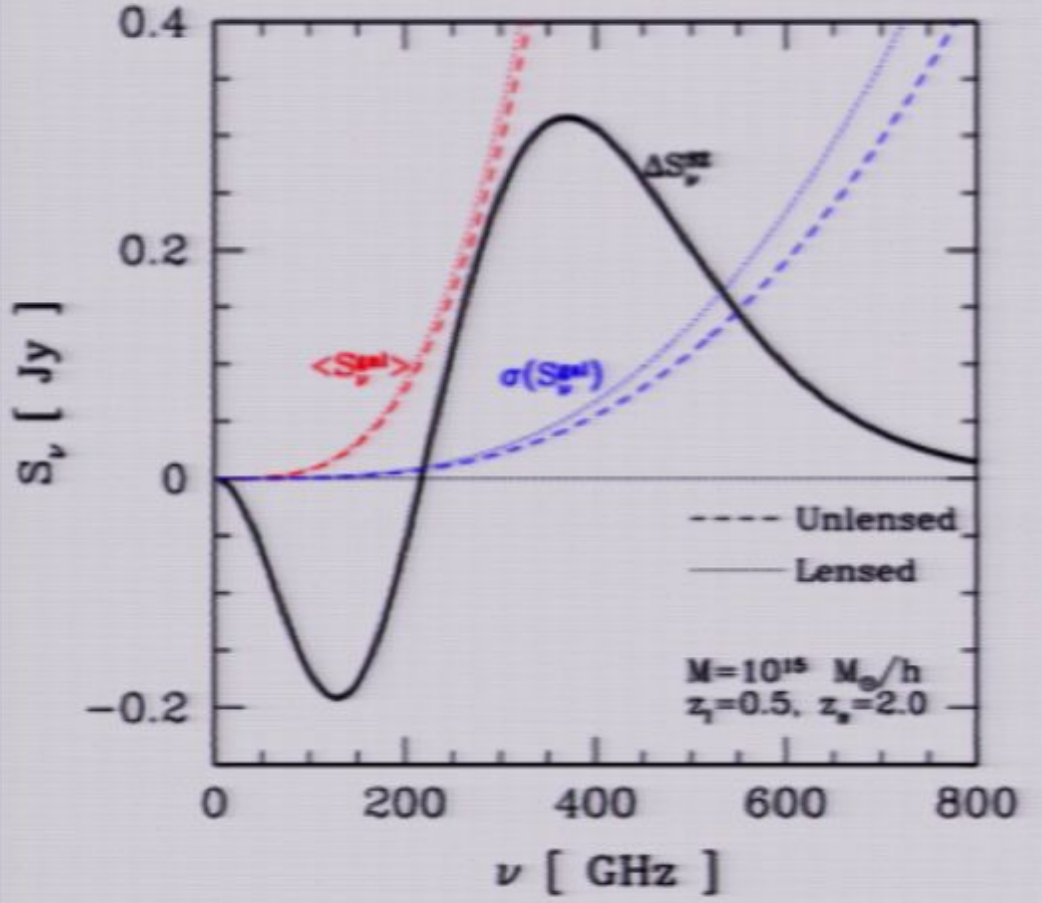

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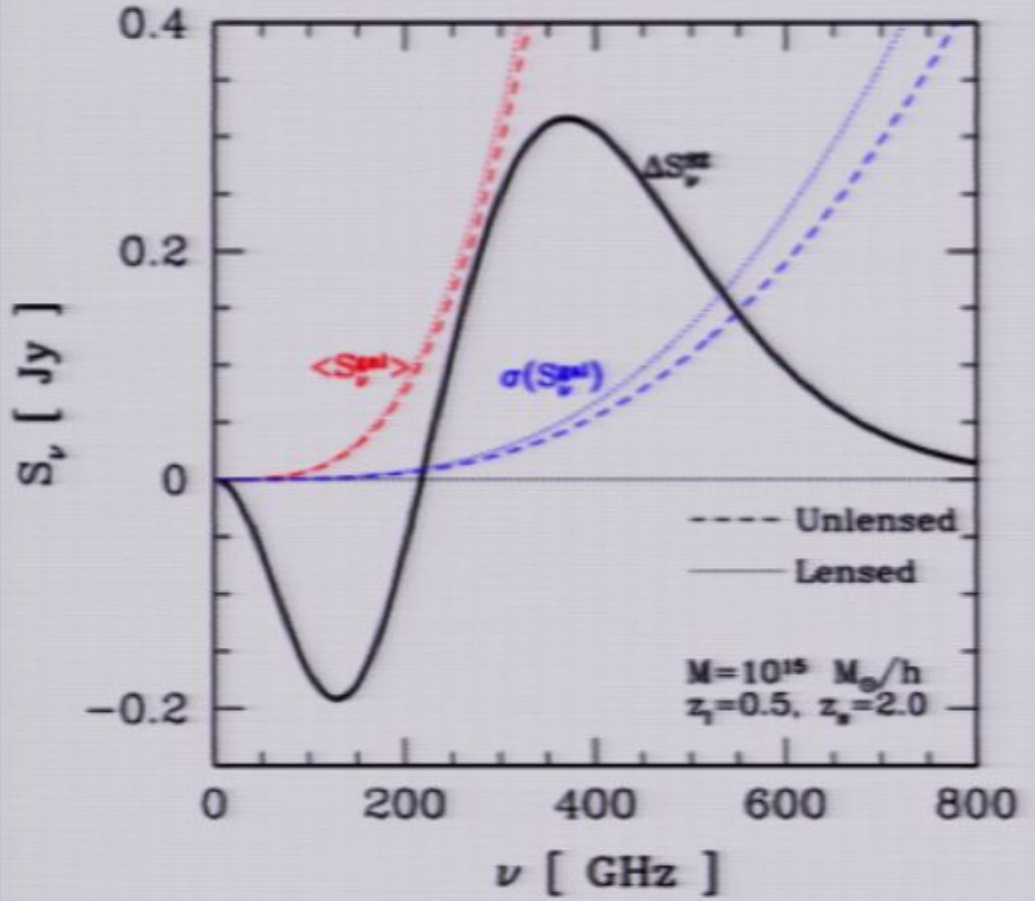

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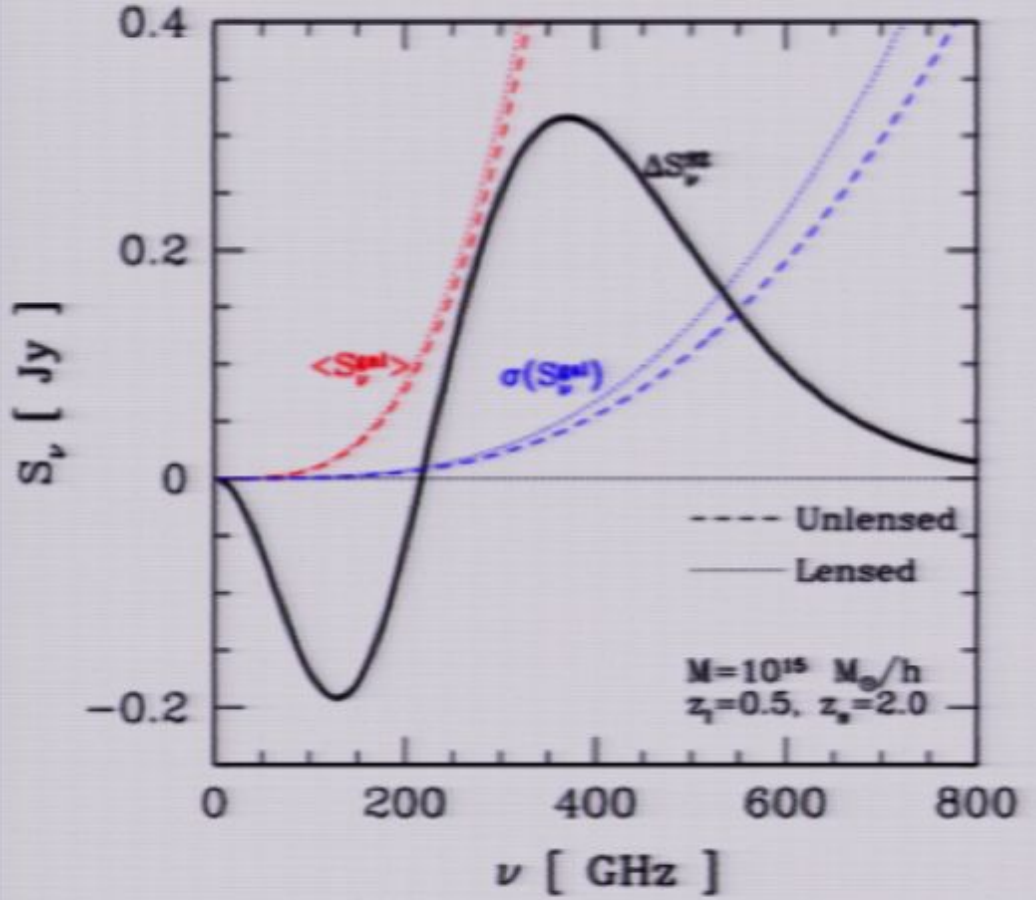

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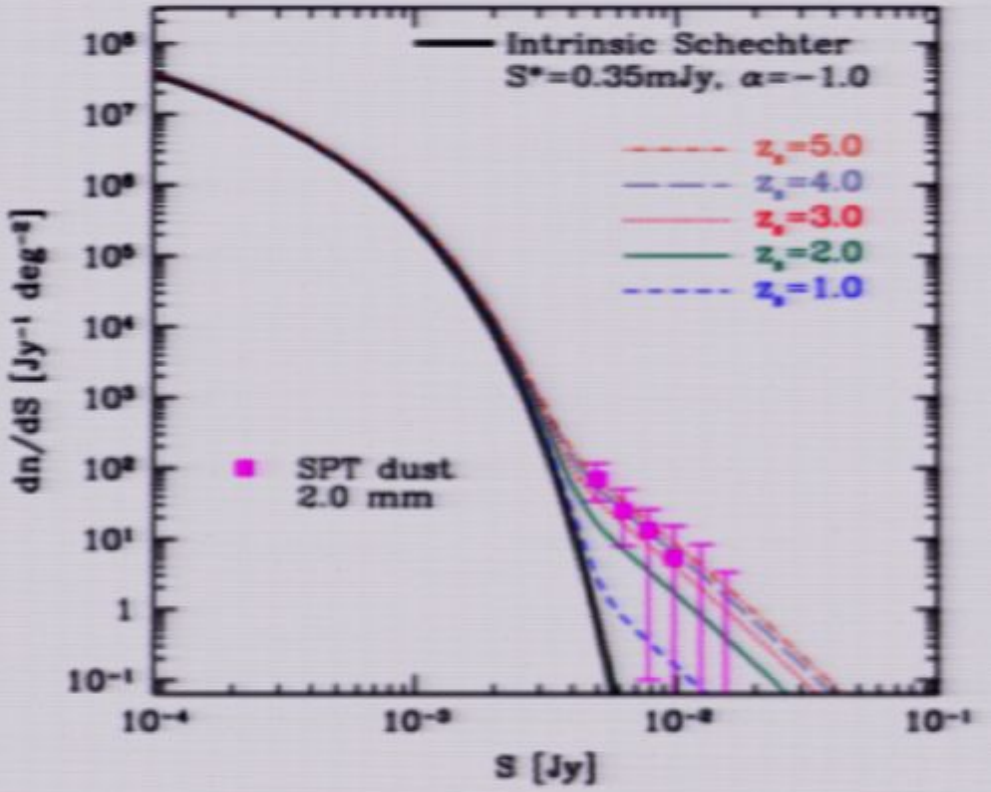
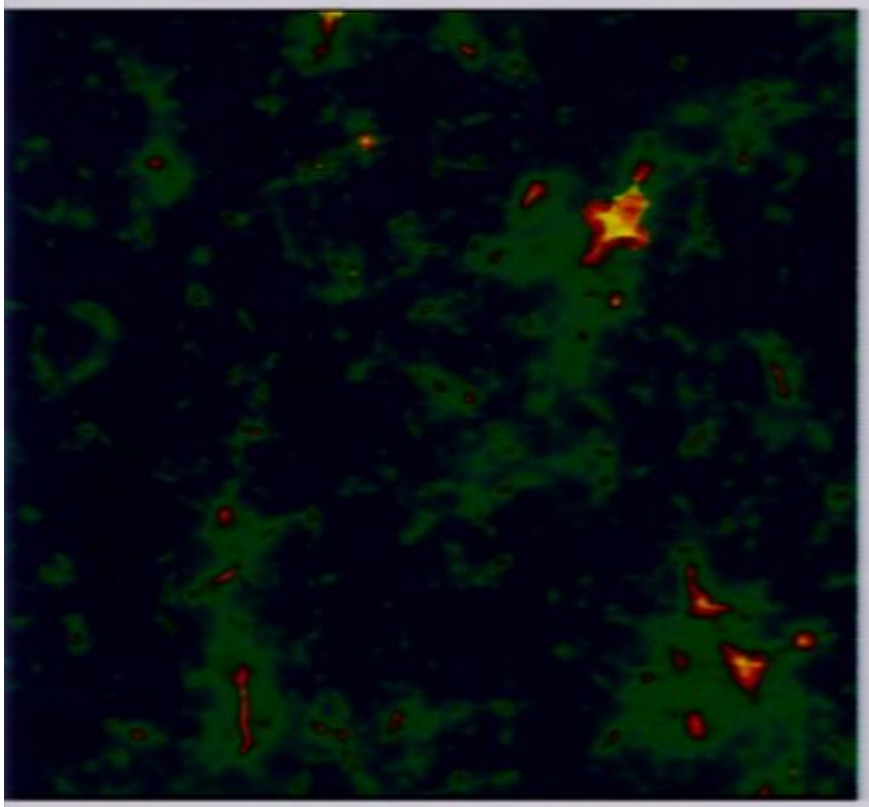
Source Galaxy Redshifts



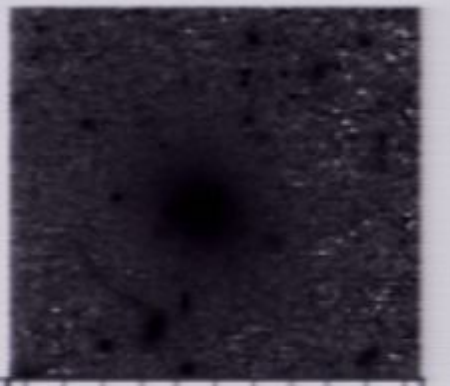
Viera et al 2010

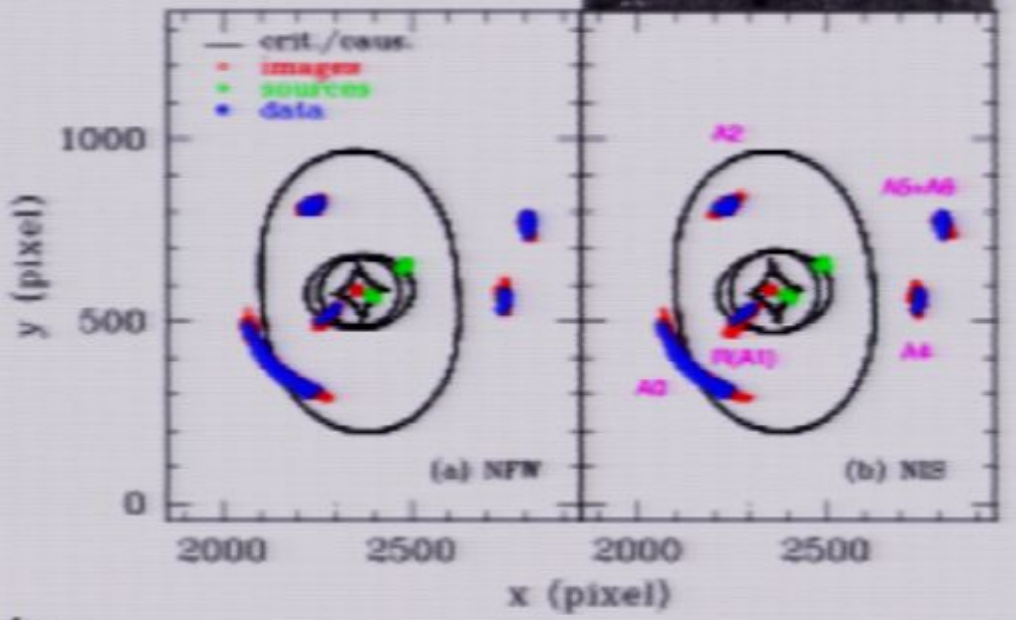
Bright SPT sources are likely at z>2

Strong lensing blues



How large are the sources?
How massive are the lenses?





Caustics in simulations and from data

Wambsganss et al; Meneghetti et al; Dalal et al.

Magnification effects on galaxy number counts

- Lensing: $S_{obs} = \mu\, S$; $d\Omega_{obs} = \mu\, d\Omega$

- Differential counts: constant μ

$$\frac{dn_{obs}(S_{obs})}{dS_{obs}} = \frac{1}{\mu^2}\frac{dn}{dS}\left(\frac{S_{obs}}{\mu}\right)$$

- Differential counts: variable μ *(Jain & Lima 2010)*

$$\frac{dn_{obs}(S_{obs})}{dS_{obs}} = \frac{1}{\langle\mu\rangle}\int d\mu \frac{P(\mu)}{\mu}\frac{dn}{dS}\left(\frac{S_{obs}}{\mu}\right)$$

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