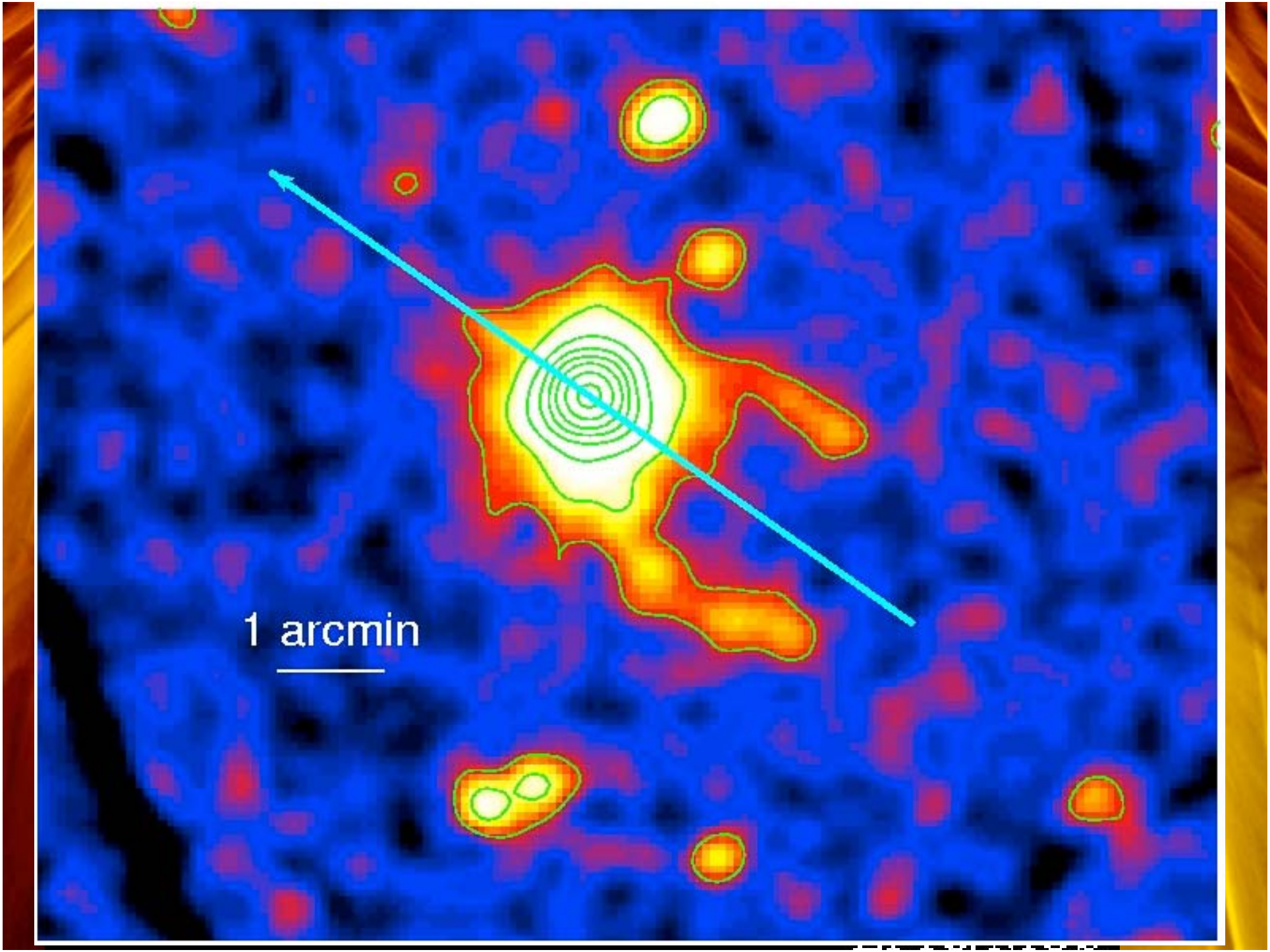

The XMM observation of Geminga
100 ksec of GT time
Geminga strikes again


1 arcmin

Energetics

Edot $3\ 10^{34}$ erg/sec

D = 160 pc

μ=170 mas/y

v_{tr} =120 km/sec

Geminga luminosity $3\ 10^{31}$ erg/sec (0.1-5 keV)

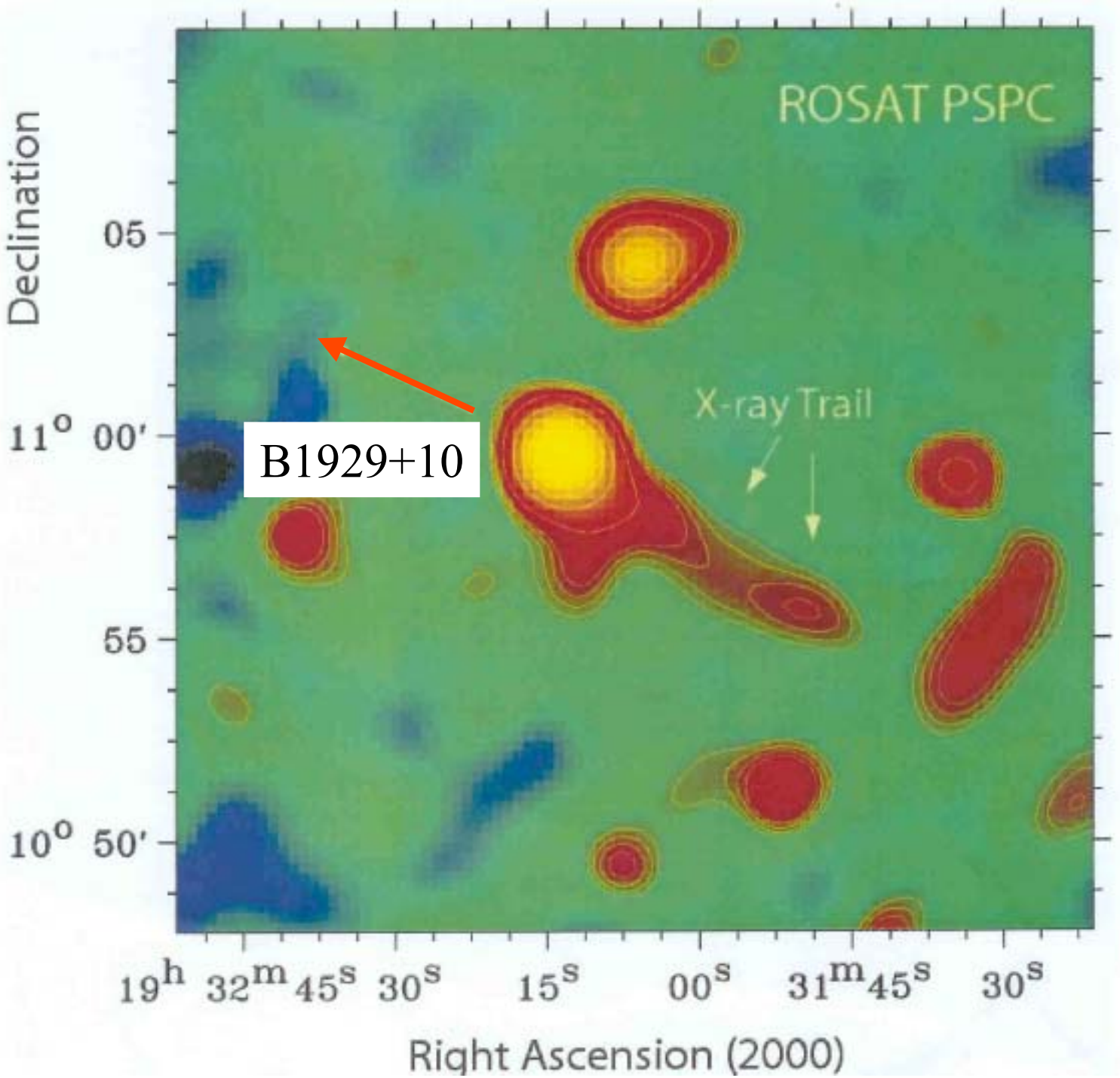
Tails luminosity $6.8\ 10^{28}$ erg/sec

The tails account for $2\ 10^{-6}$ Edot

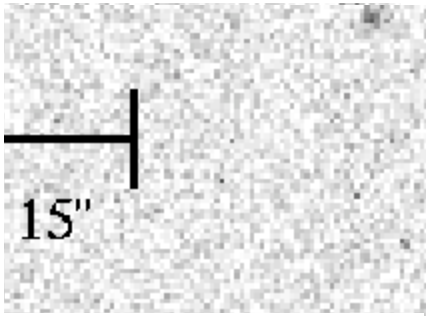
What could this be ?

A tail like this one ?

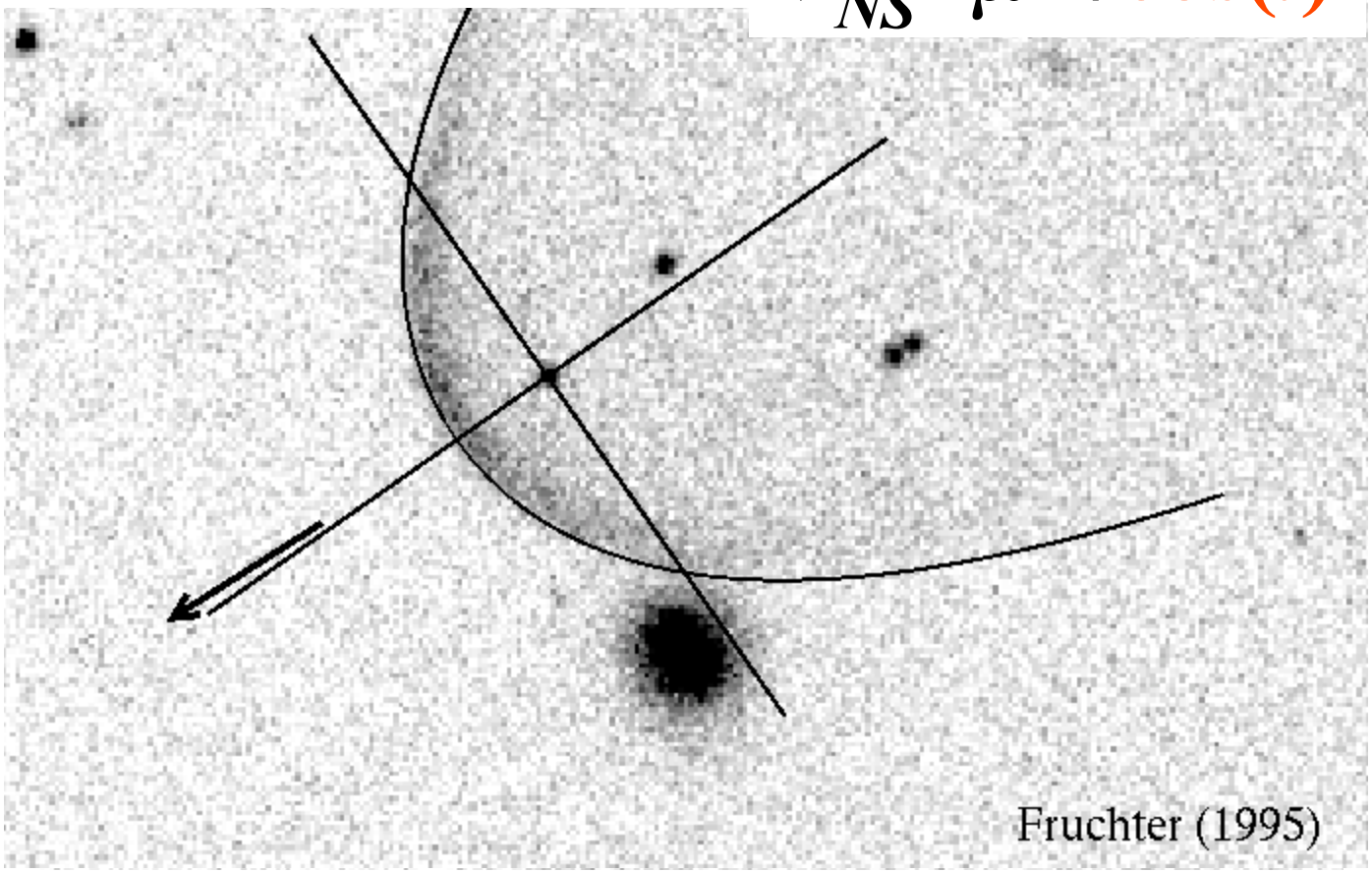
No, our tails carry % of E_{dot} 100 times smaller

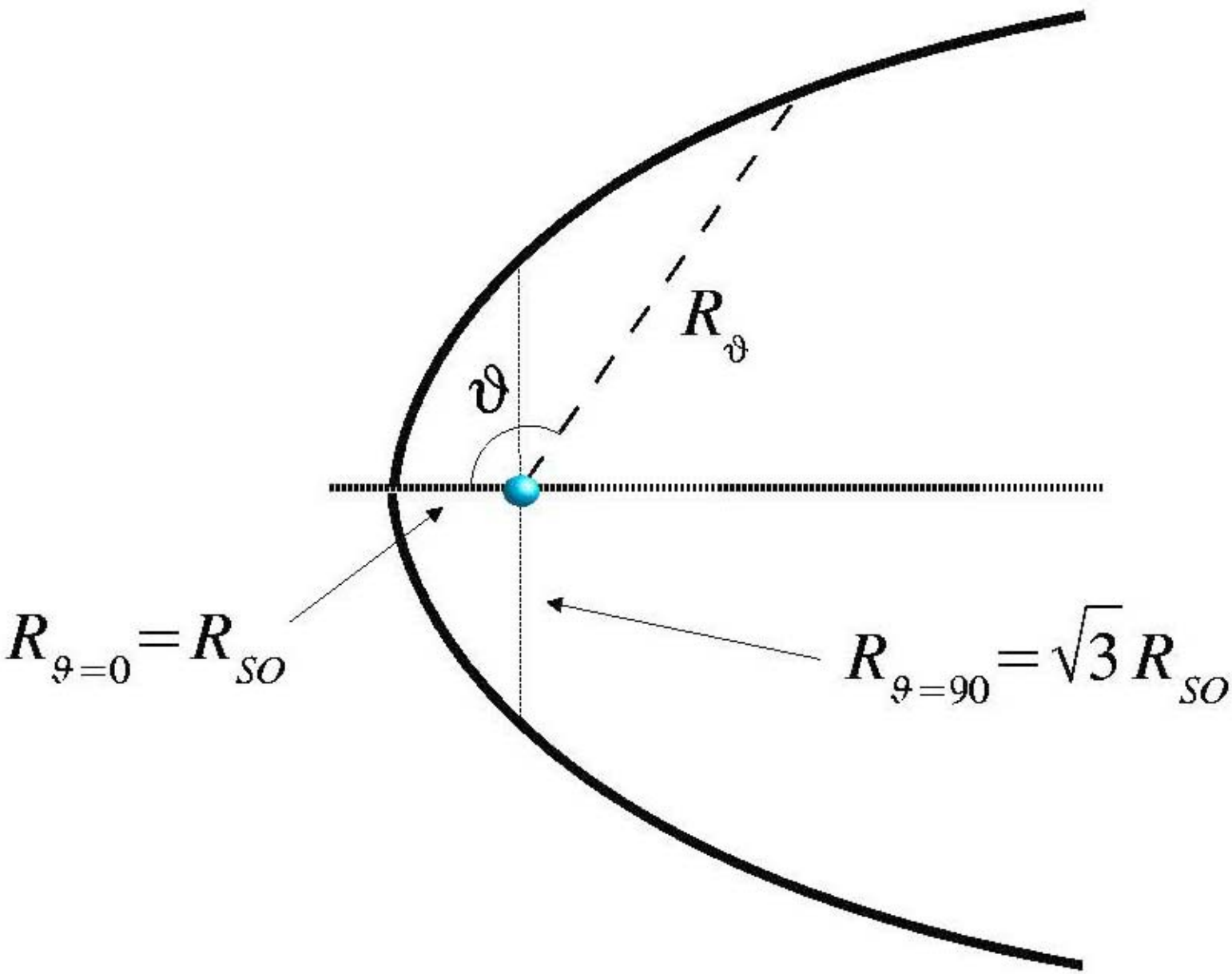


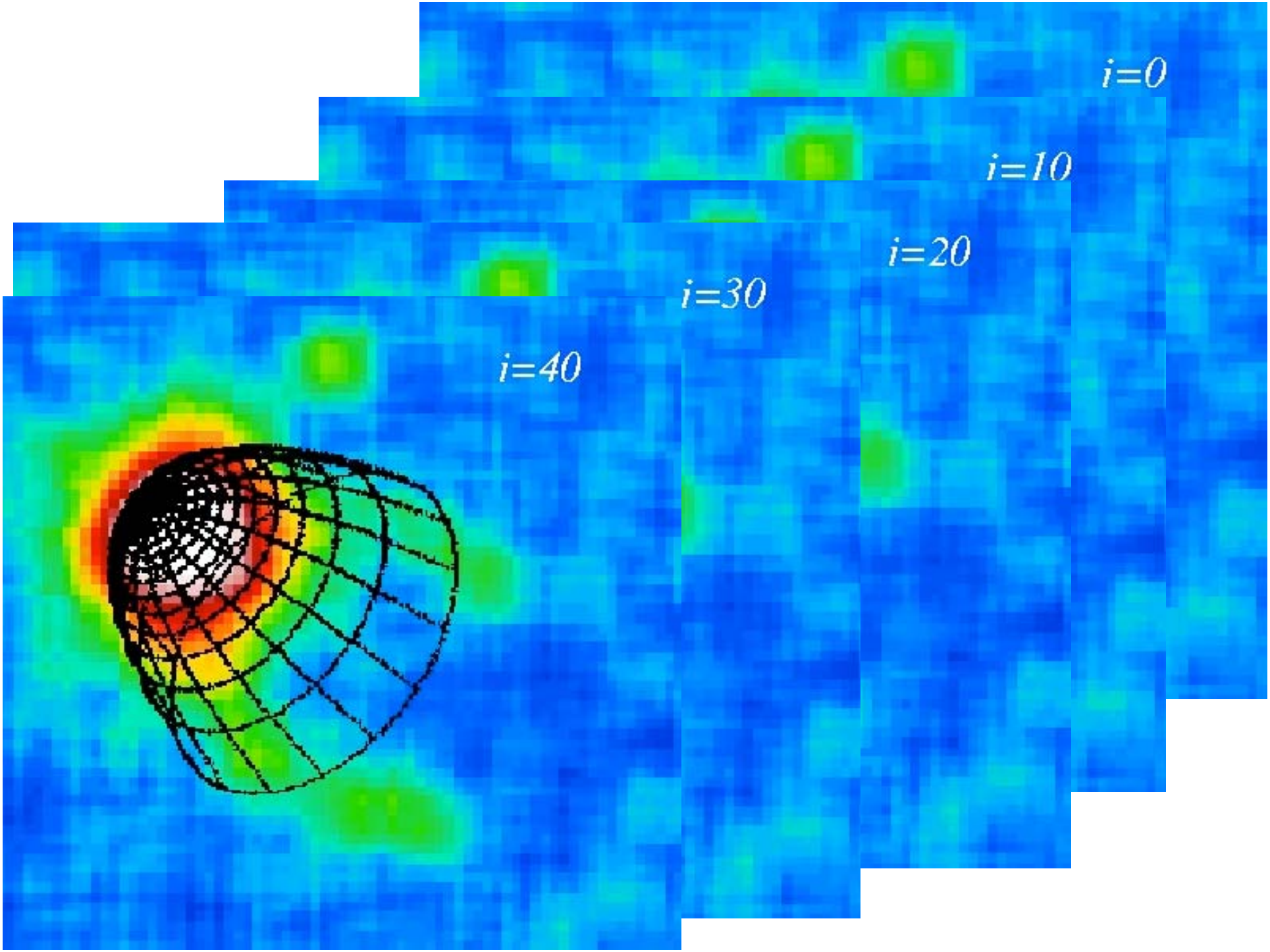
$$\frac{\dot{E}}{4\pi R_{SO}^2 c} = \rho_{ISM} V_{NS}^2$$

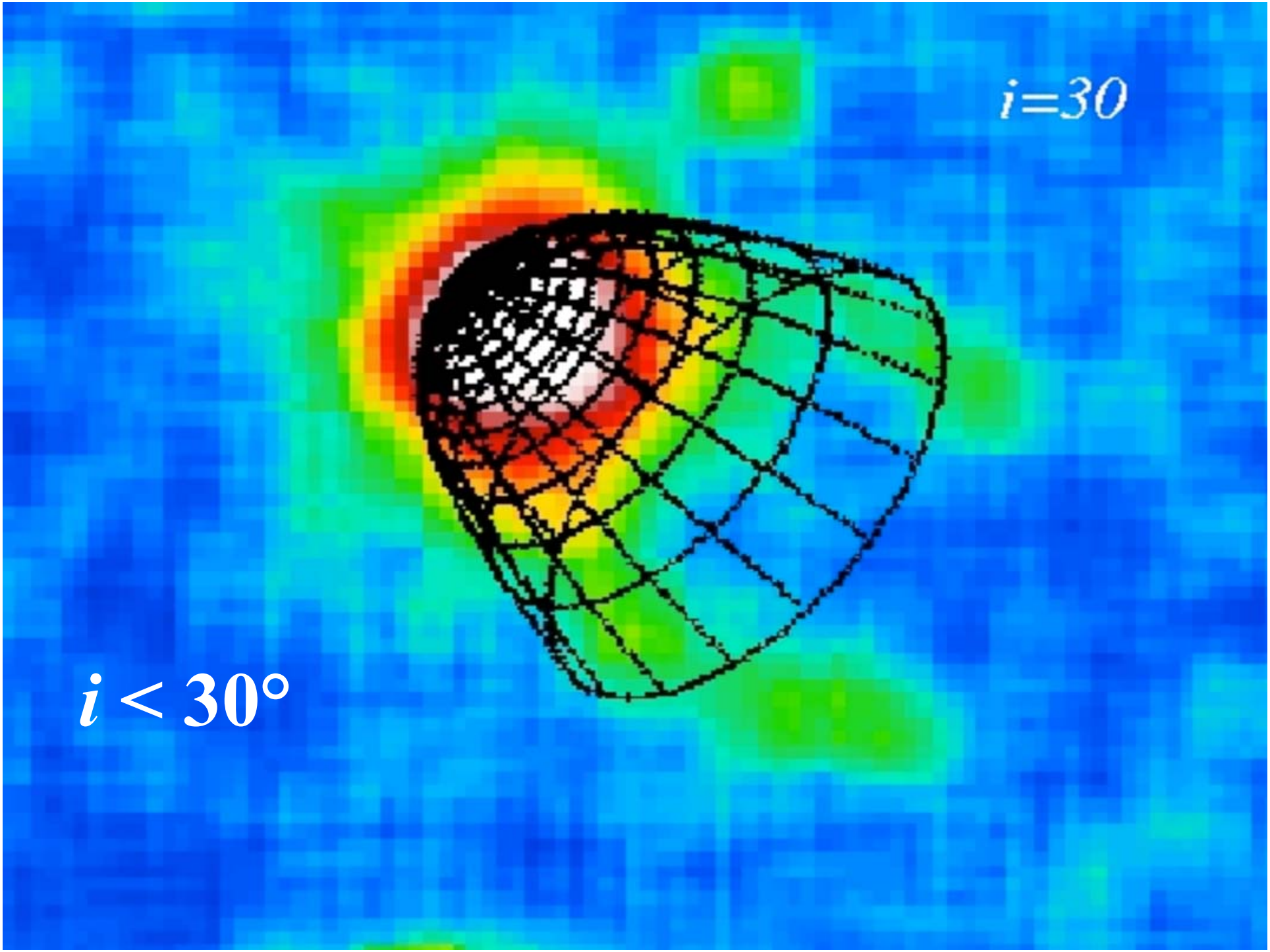


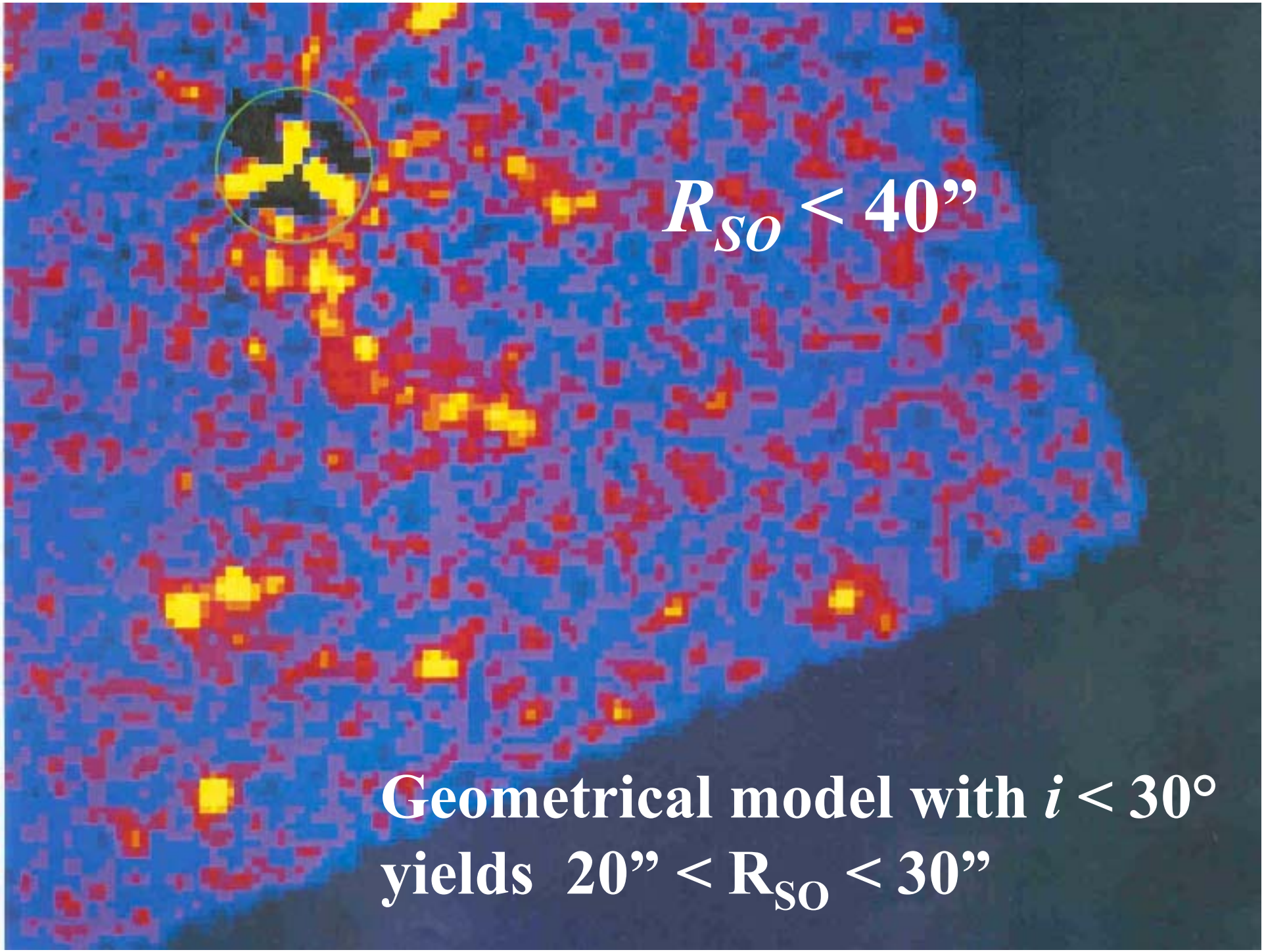
$$V_{NS} = \mu D / \cos(i)$$




R_ϑ
ϑ
$R_{\vartheta=0} = R_{SO}$
$R_{\vartheta=90} = \sqrt{3}\, R_{SO}$

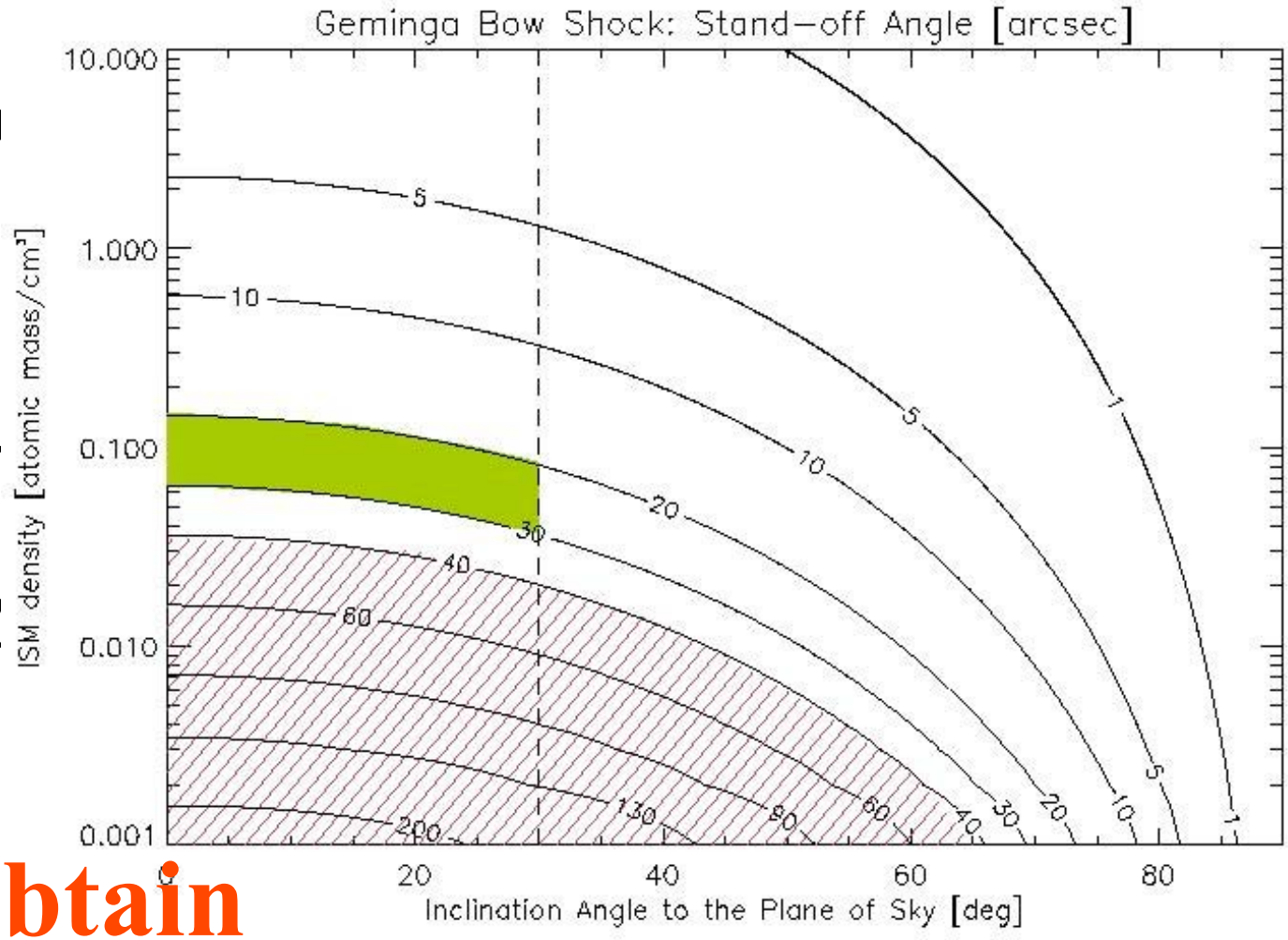

i=0
i=10
i=20
i=30
i=40


i=30
i < 30°


$R_{SO} < 40$”
Geometrical model with $i < 30°$
yields 20” < R_{SO} < 30”

from bo

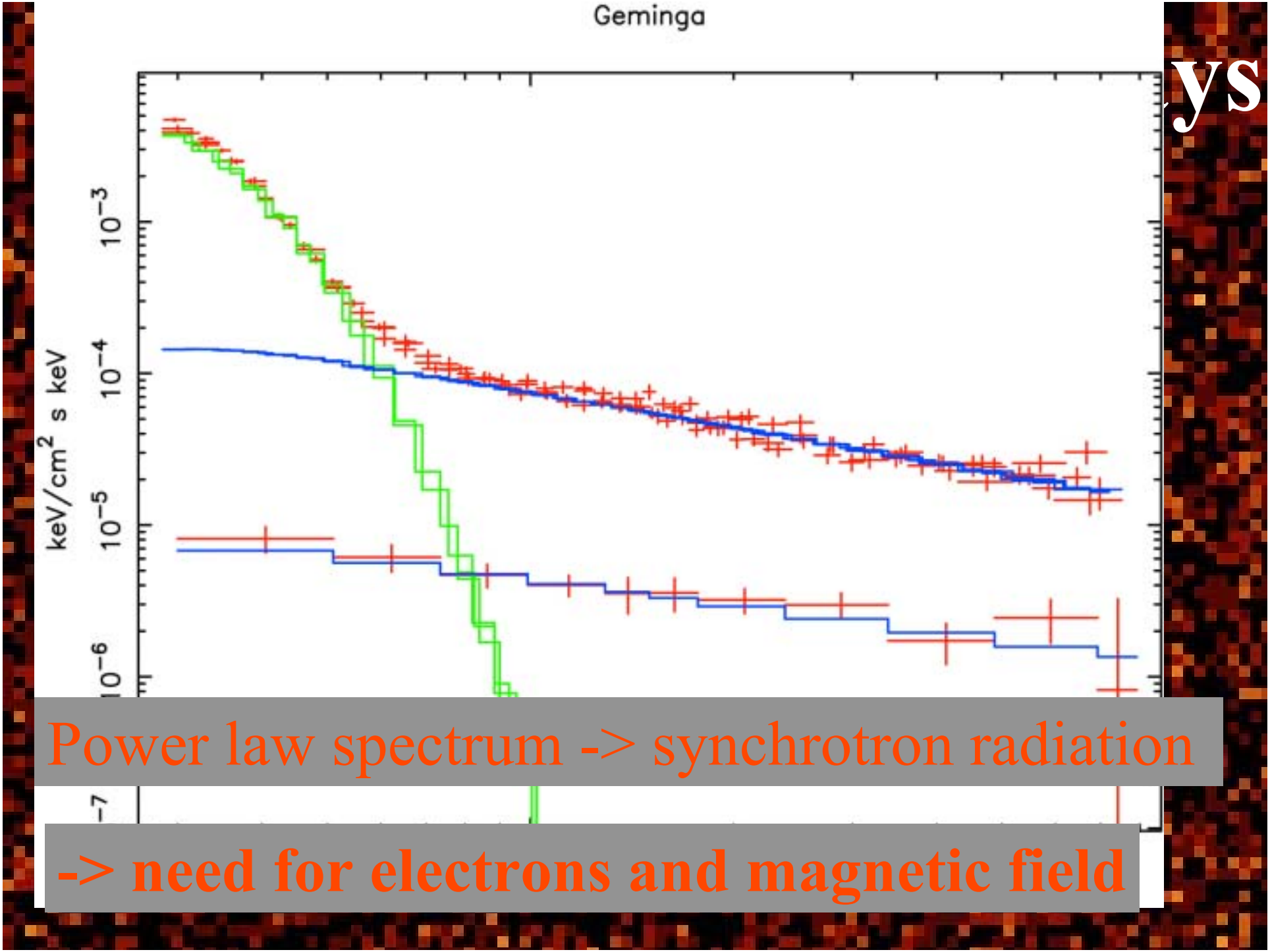
$$\frac{\dot{E}}{4\pi R_{St}^2}$$



we can obtain

$0.06 < \rho_{ISM} < 0.15$ at/cm^{-3}

which implies $7 < M < 20$


Geminga
keV/cm^2 s keV
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
Power law spectrum -> synchrotron radiation
-> need for electrons and magnetic field

From bow-shock theory

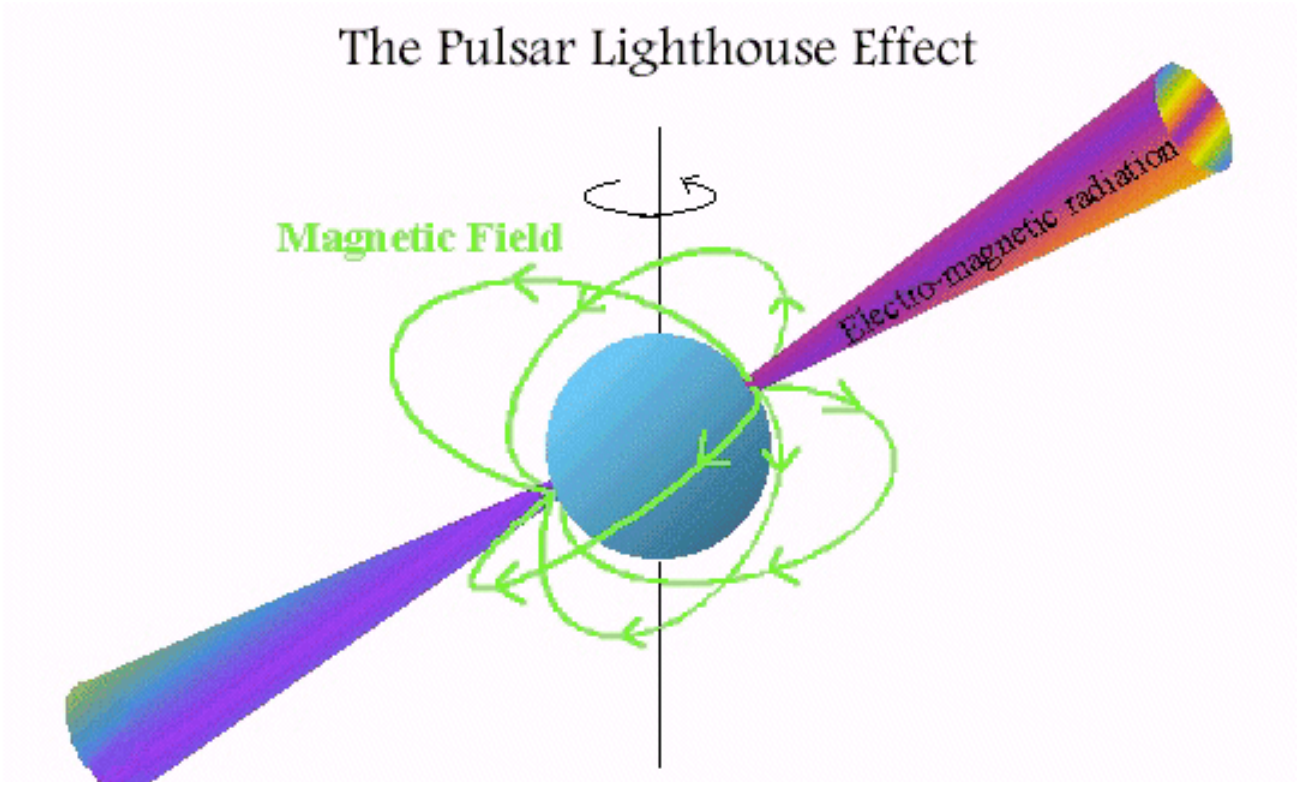
$$\rho_{shock} = 4\,\rho_{ISM}$$

Since B is frozen-in

$$B_{shock} = 4\,B_{ISM}$$

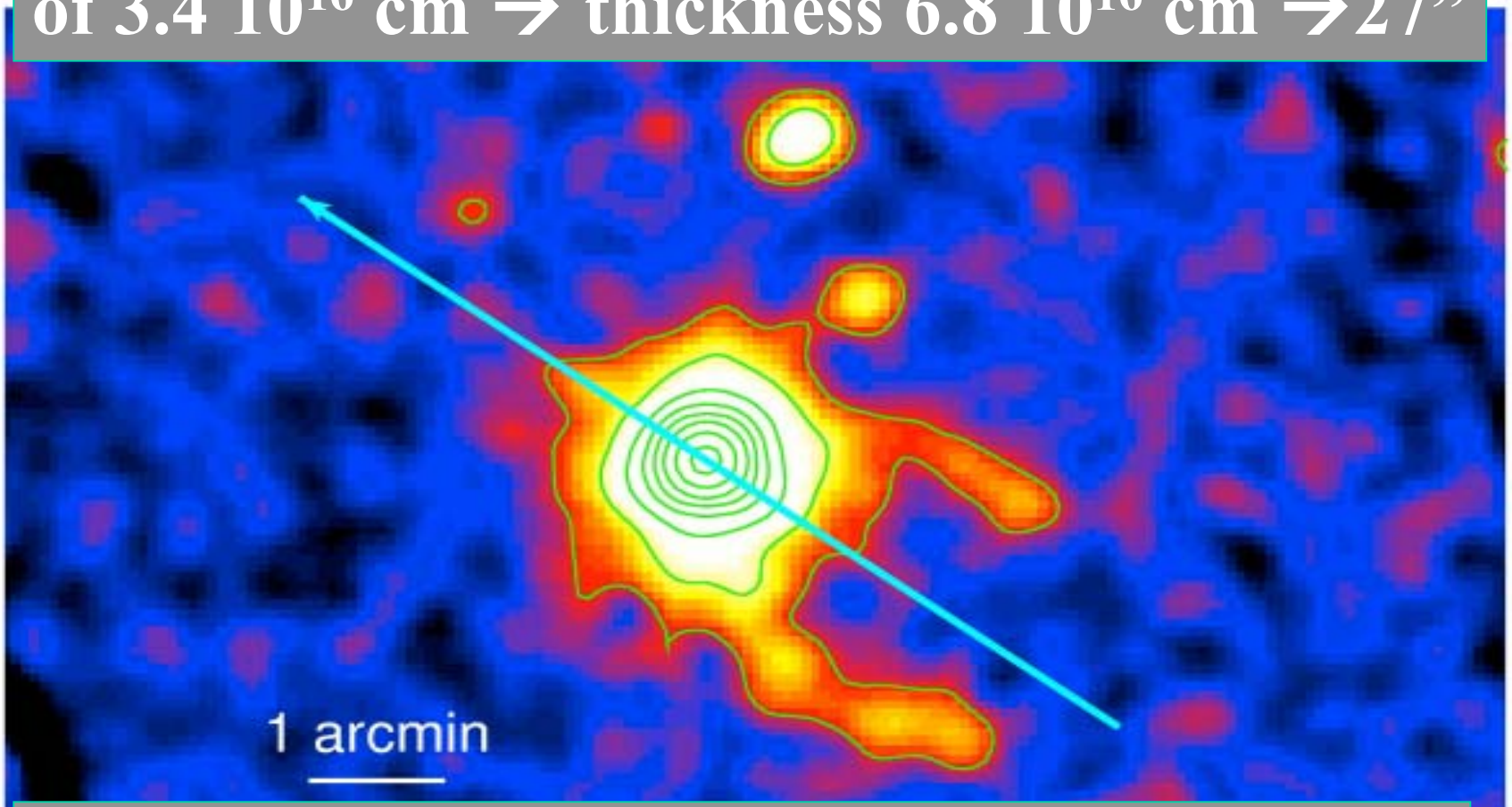
$$B_{shock} = 10^{-5}\ G$$

To produce keV photons in 10^{-5} G B field one needs 10^{14} eV electrons

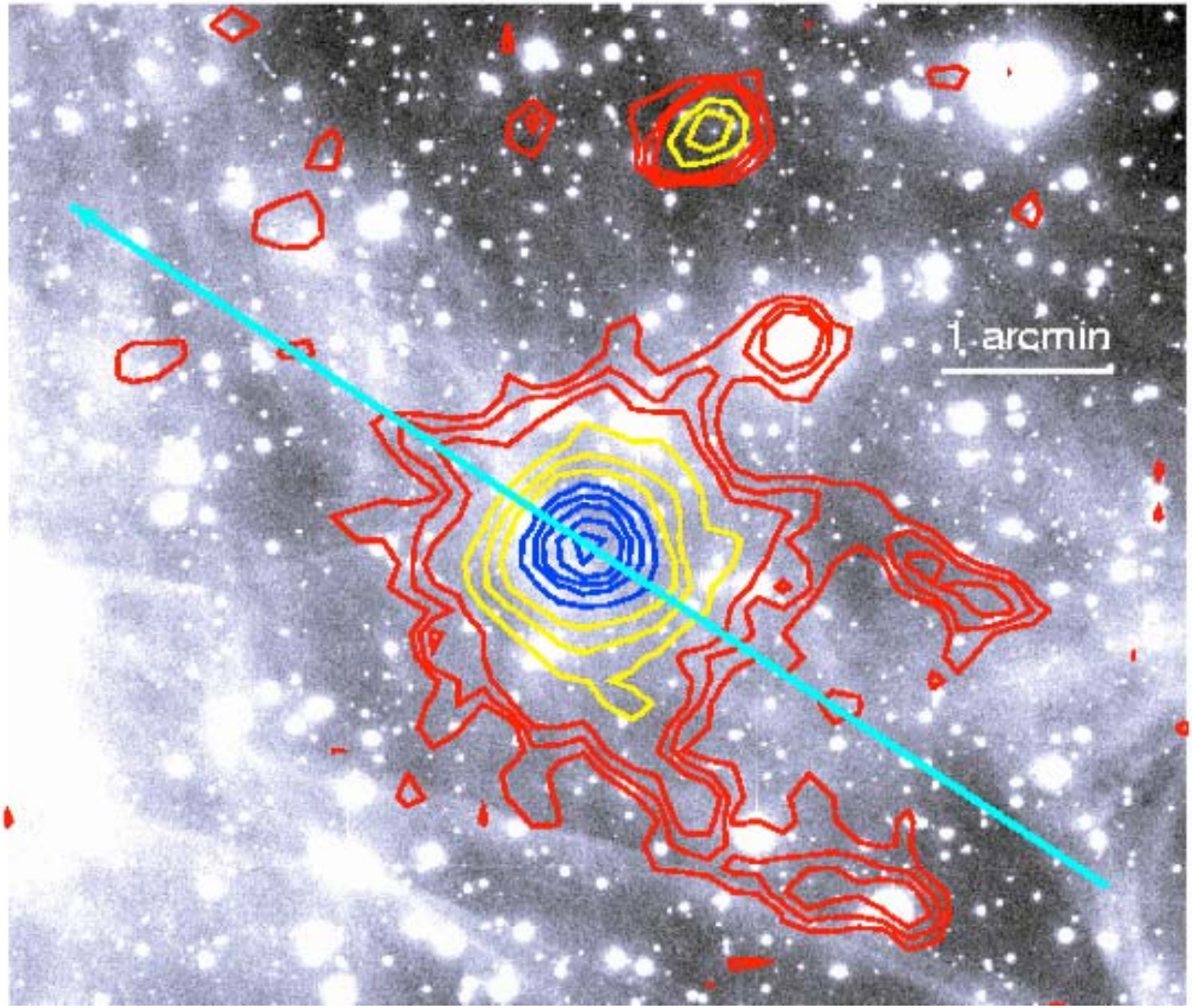


$$\Delta V_{\max} \sim \frac{\Omega^2 B_p R^3}{2c^2} \sim \frac{I\Omega\dot{\Omega}}{e\dot{N}_0} \sim 2 \times 10^{14}\ \mathrm{V},$$

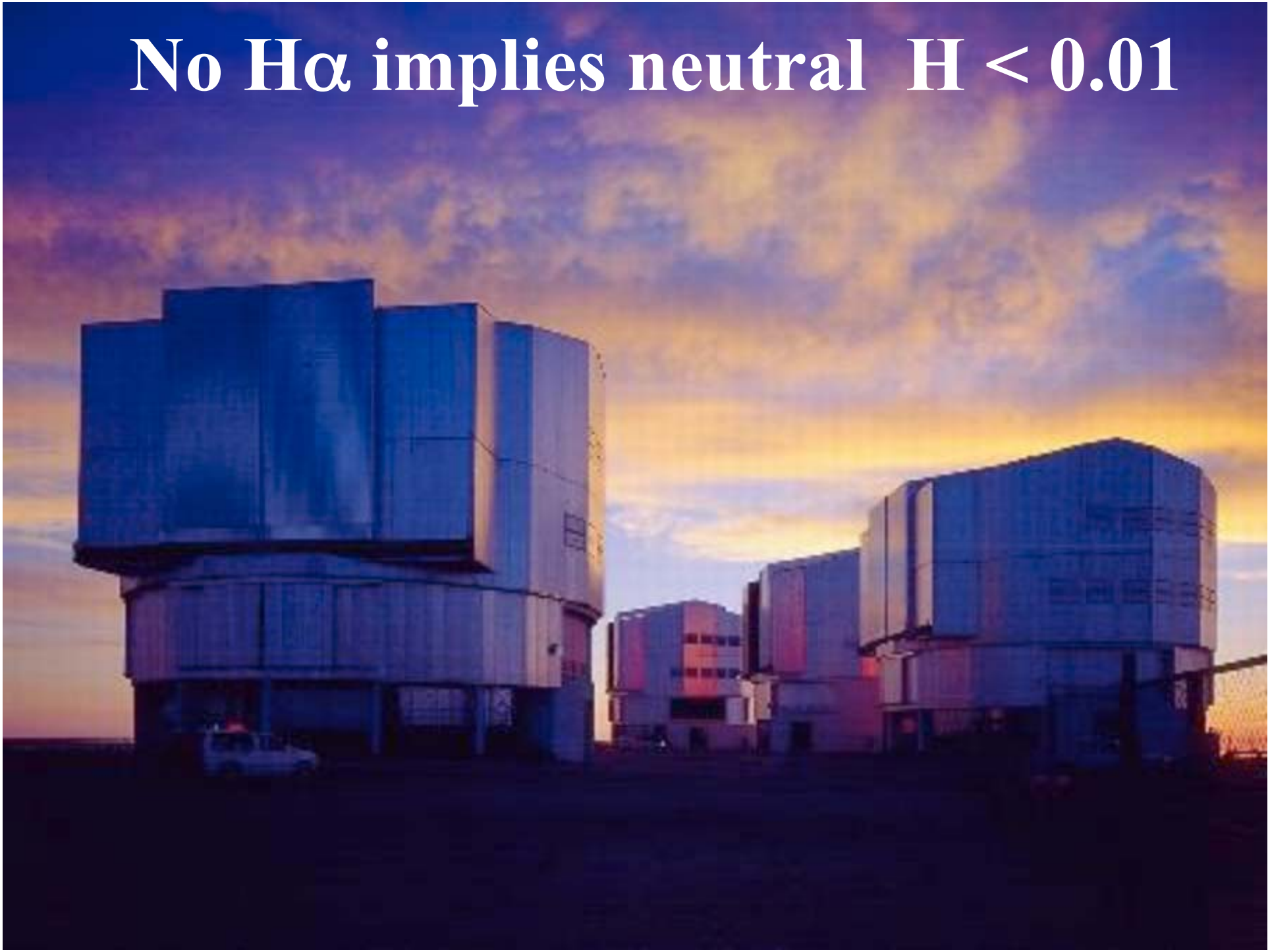
10^{14} eV electrons will have a Larmor radius of 3.4 10^{16} cm → thickness 6.8 10^{16} cm →27”



10^{14} eV electrons will loose half of their energy in 800 y .
180 “ / 170 mas/y = 1,000 y


1 arcmin

No Hα implies neutral H < 0.01



Conclusions

Geminga accelerates electrons up to E 10^{14} eV

$0.06 < \rho_{ISM} < 0.15$ at/cm^{-3}

$B_{ISM} < 2\text{-}3\ 10^{-6}$ Gauss

The ISM is fully ionized by Geminga