Stellar winds as a braker of the central object

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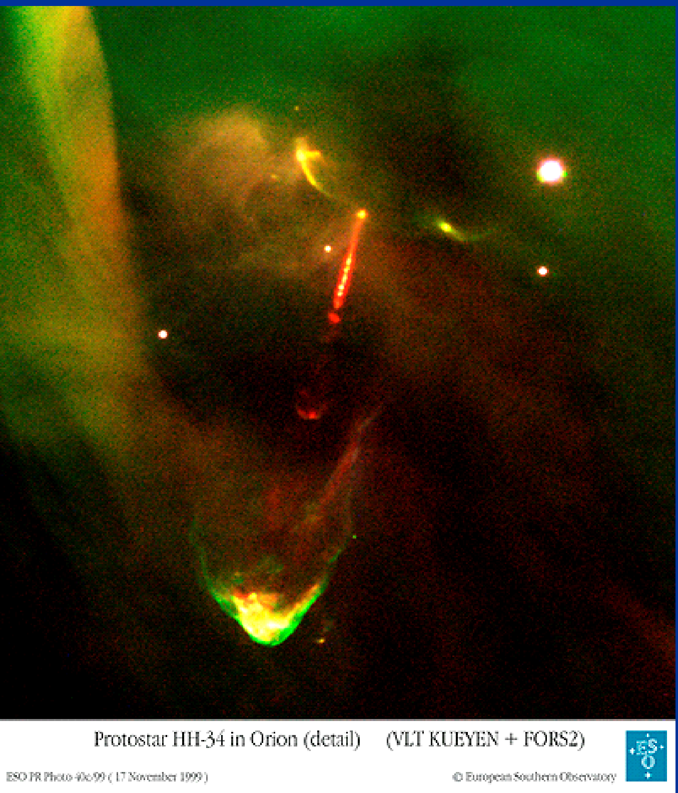
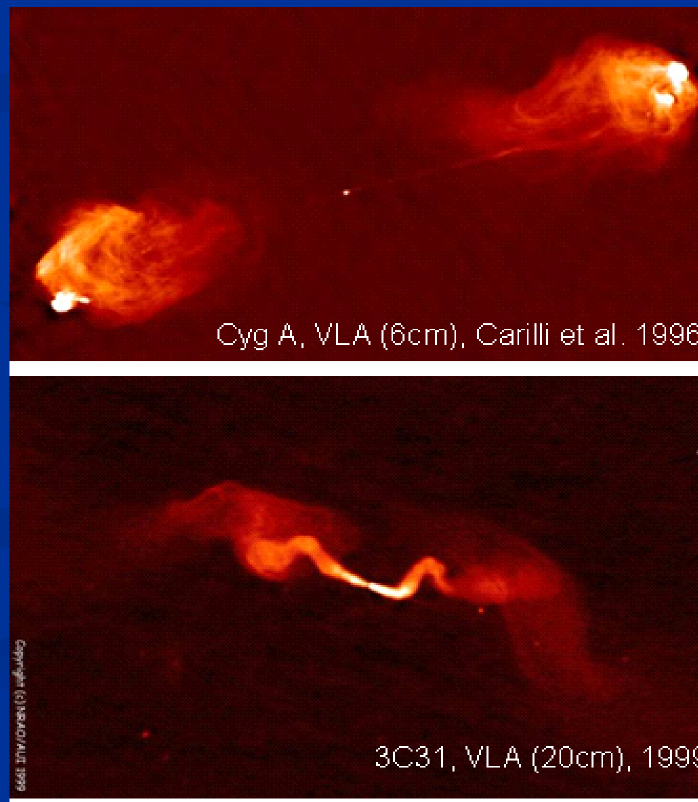
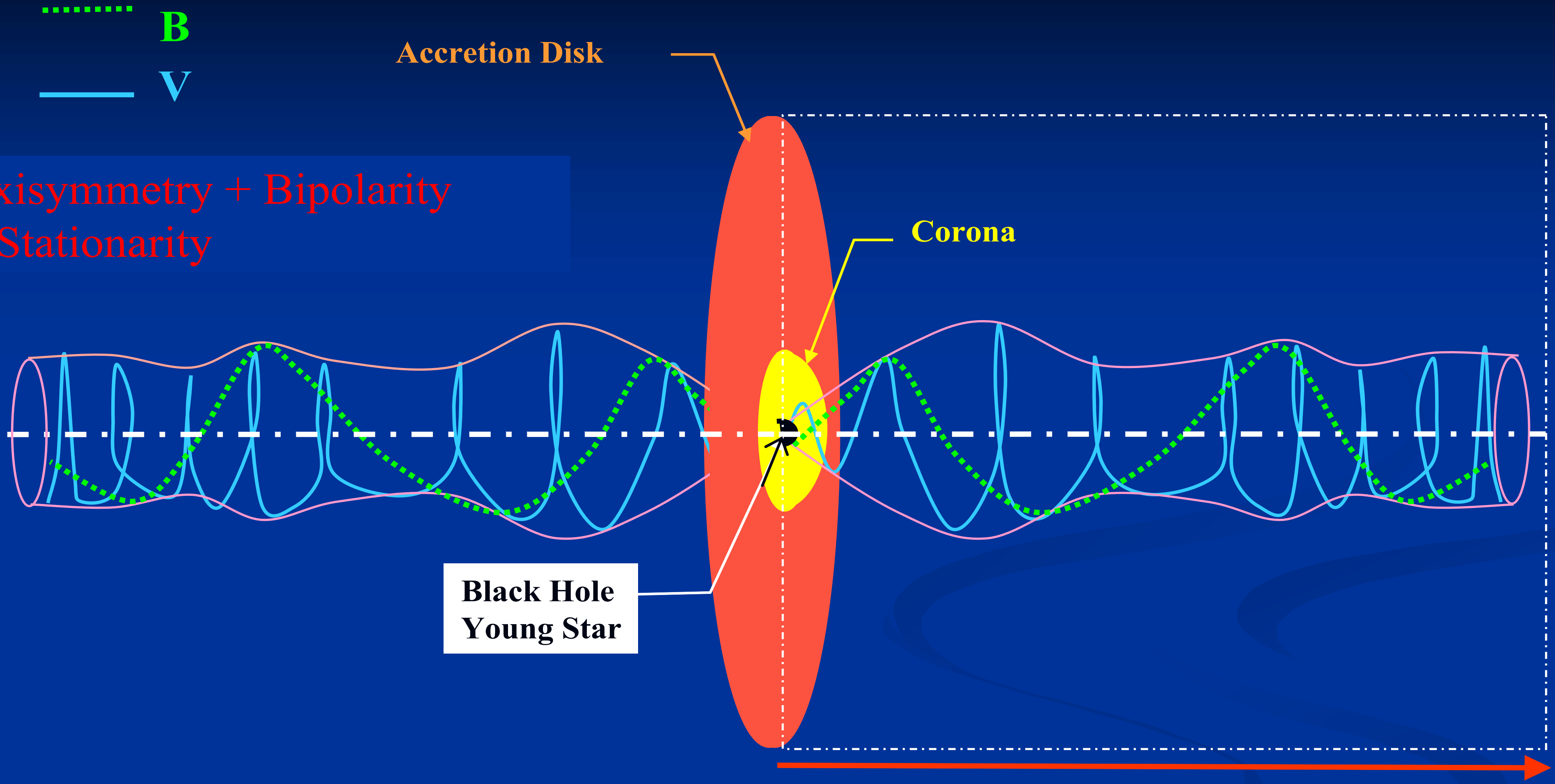




3D Schematic View

Axisymmetry + Bipolarity
+ Stationarity



Source

- Disk
- Central Black Hole / New Star
- Connection disk-BH/star = X-wind

Formation/ Acceleration

- Thermal
- Magnetic

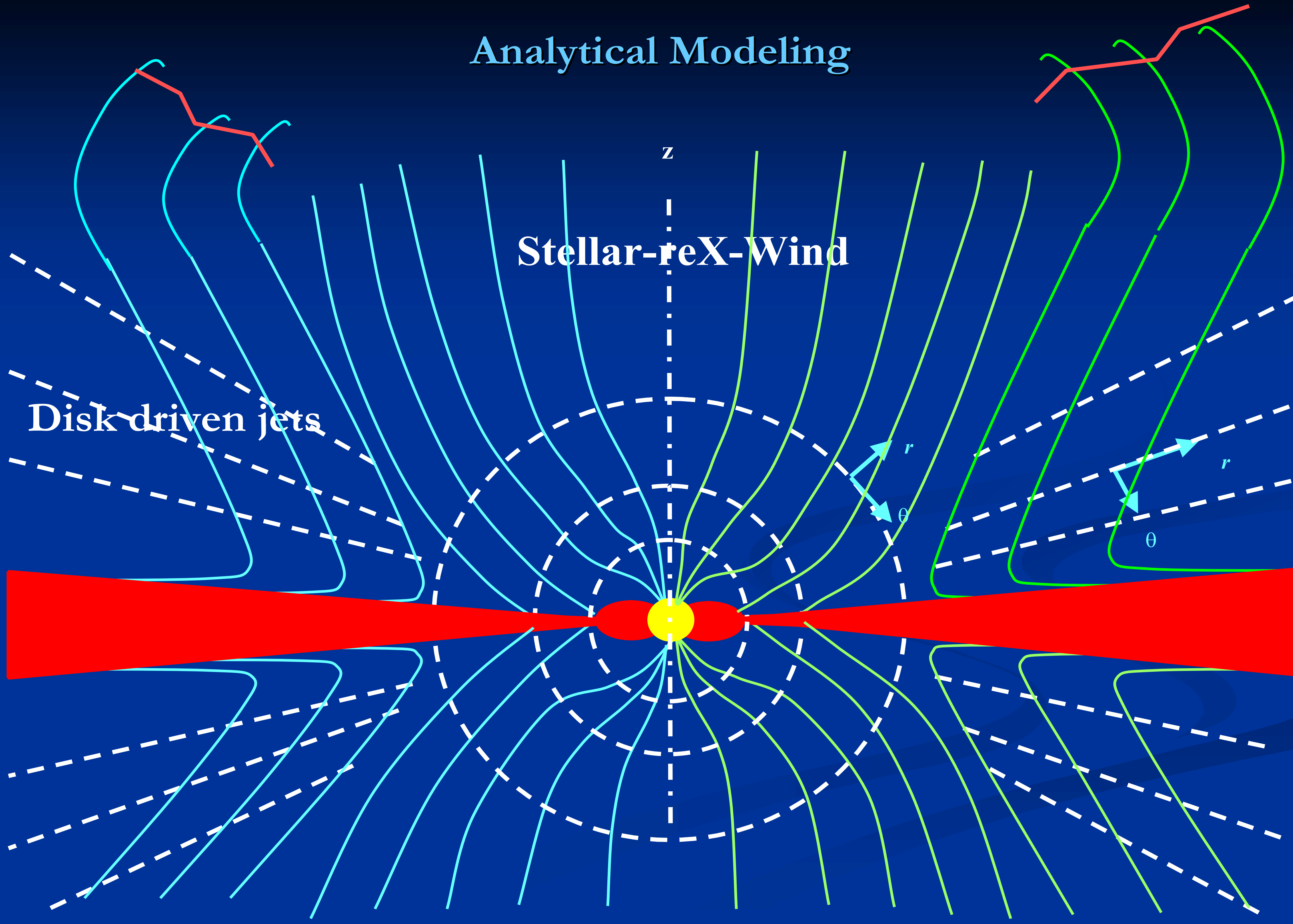
Collimation

- Pressure
- Magnetic

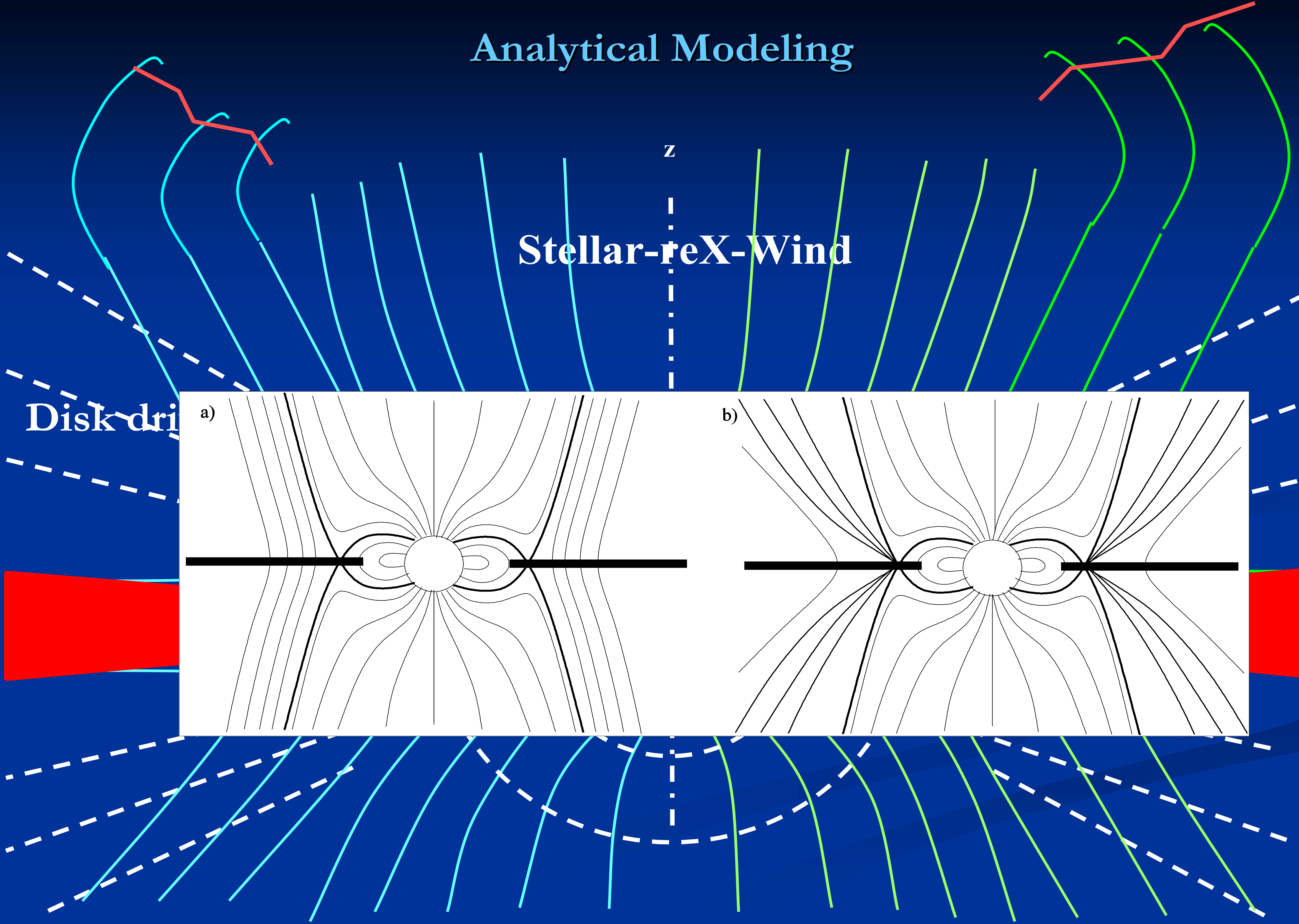
Propagation :

- shocks
- reacceleration
- radiation

Analytical Modeling



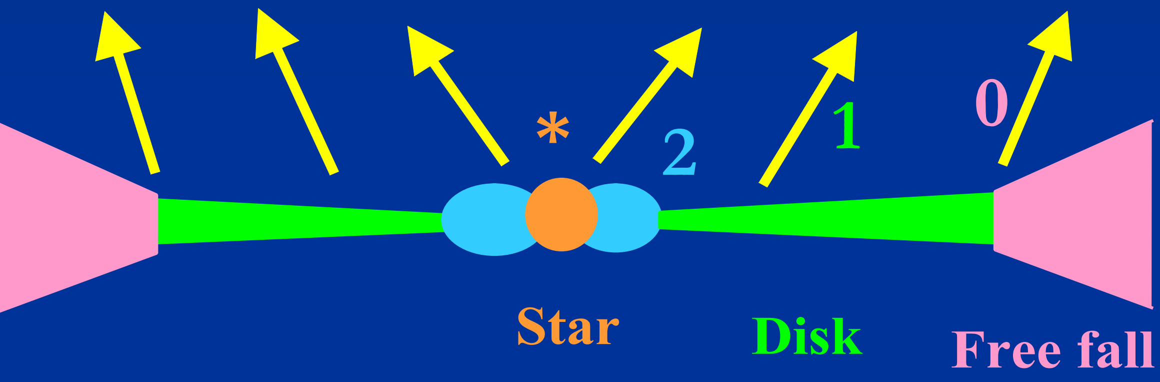
Analytical Modeling



Evolution of jets from YSOs

YSO Jets class 0
ε >> 0 ?
Disk driven Jet – No star ?

YSO Jets class 1
ε > 0 ?
Disk Driven Jet



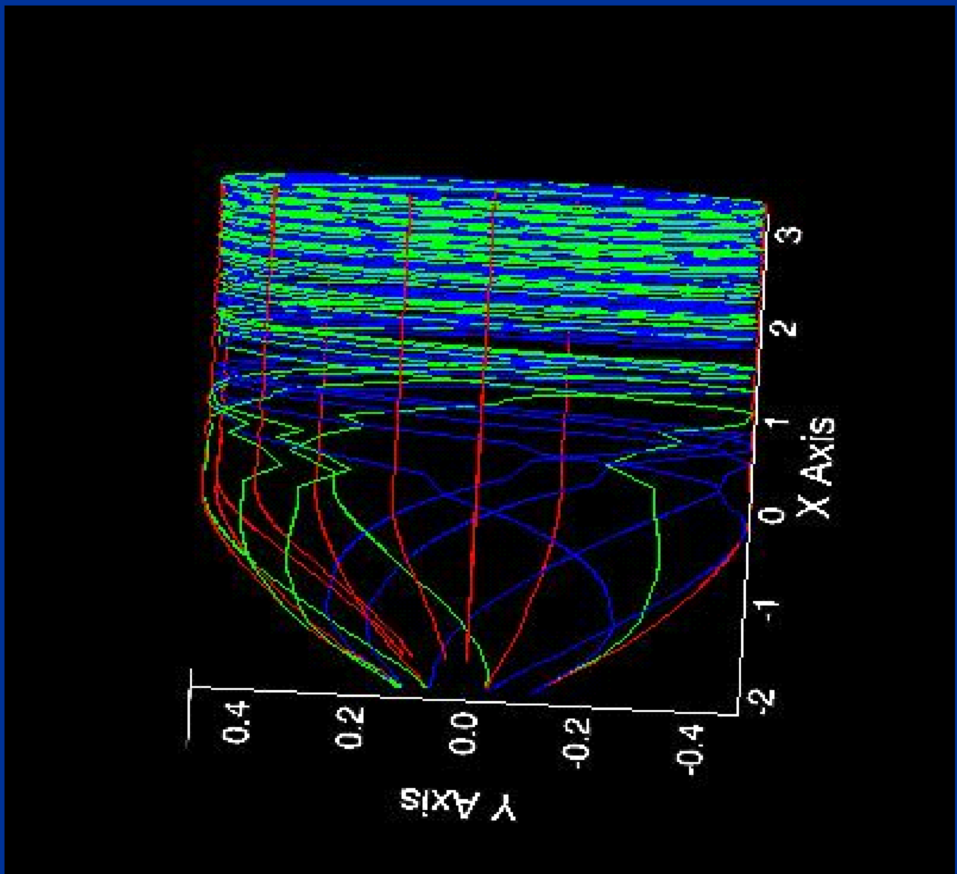
T Tauri
YSO Jet class 2
ε ~ 0
Star/Disk Boundary driven Jet

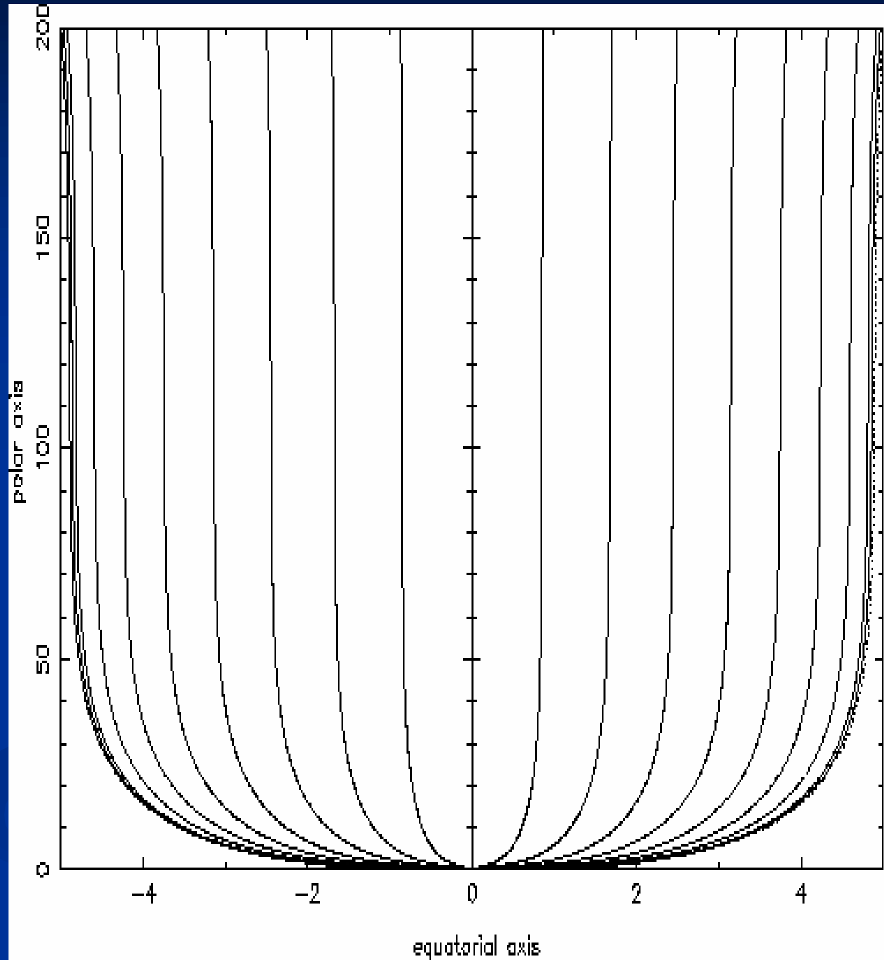
Stellar Winds
ε=−50

- From disk-driven to star-driven
- Decreasing efficiency of the magnetic rotator

Low mass accreting TTauri stars

- Observational constraints from RY Tau, lk C15, DE Tau, GK Tau, DR Tau, IP Tau
  - Ω star
  - Density before the shock
  - Asymptotic speed
  - Transition under/over pressured ~50 AU





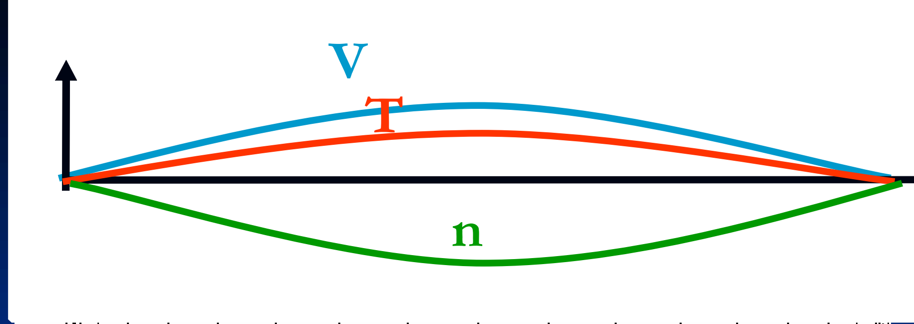
Meliani, 2001, DEA

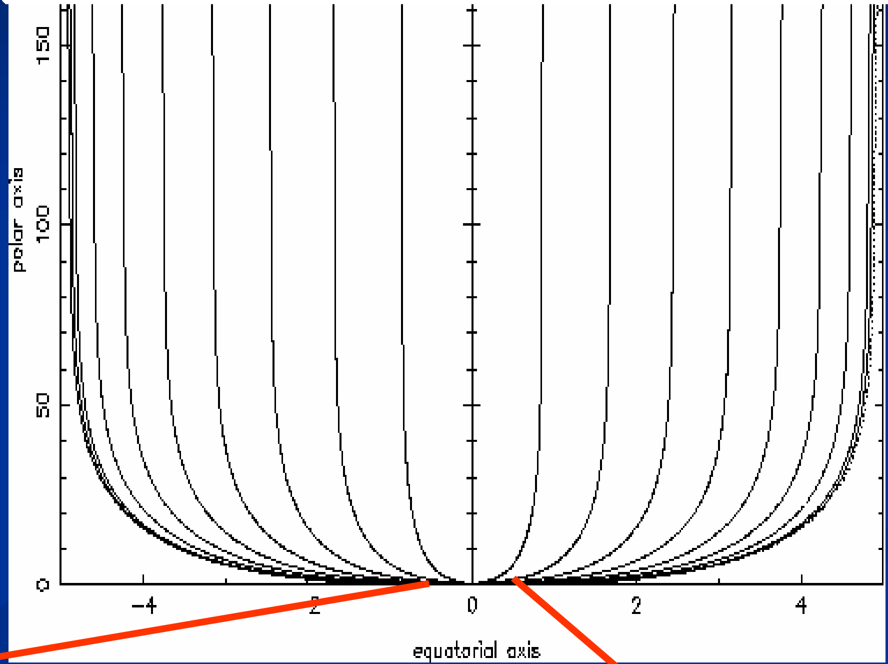
Low mass accreting jets from TTauris

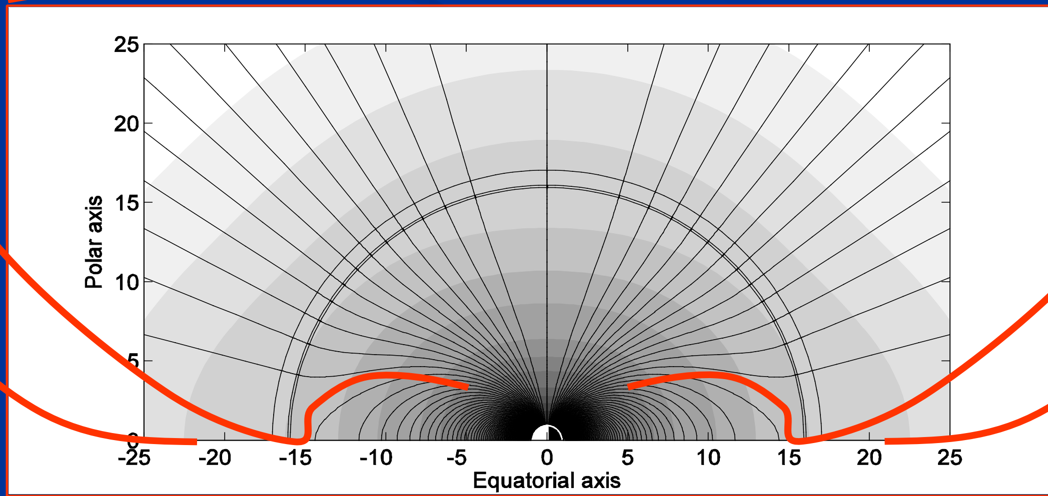
- Mass Loss Rate :
  - 10^{-10} $M_\odot$/yr - Stellar Wind
  - 10^{-9} $M_\odot$/yr - within 3 R_* of the disk
  - Disk subkeplerian close to *
  - Flat Vphi
  - Consistent Stellar-X-wind model
- Consistent Temperature ?
  - $10^5 - 10^3$ K
  - Effective polar T,

  cf. Solar wind

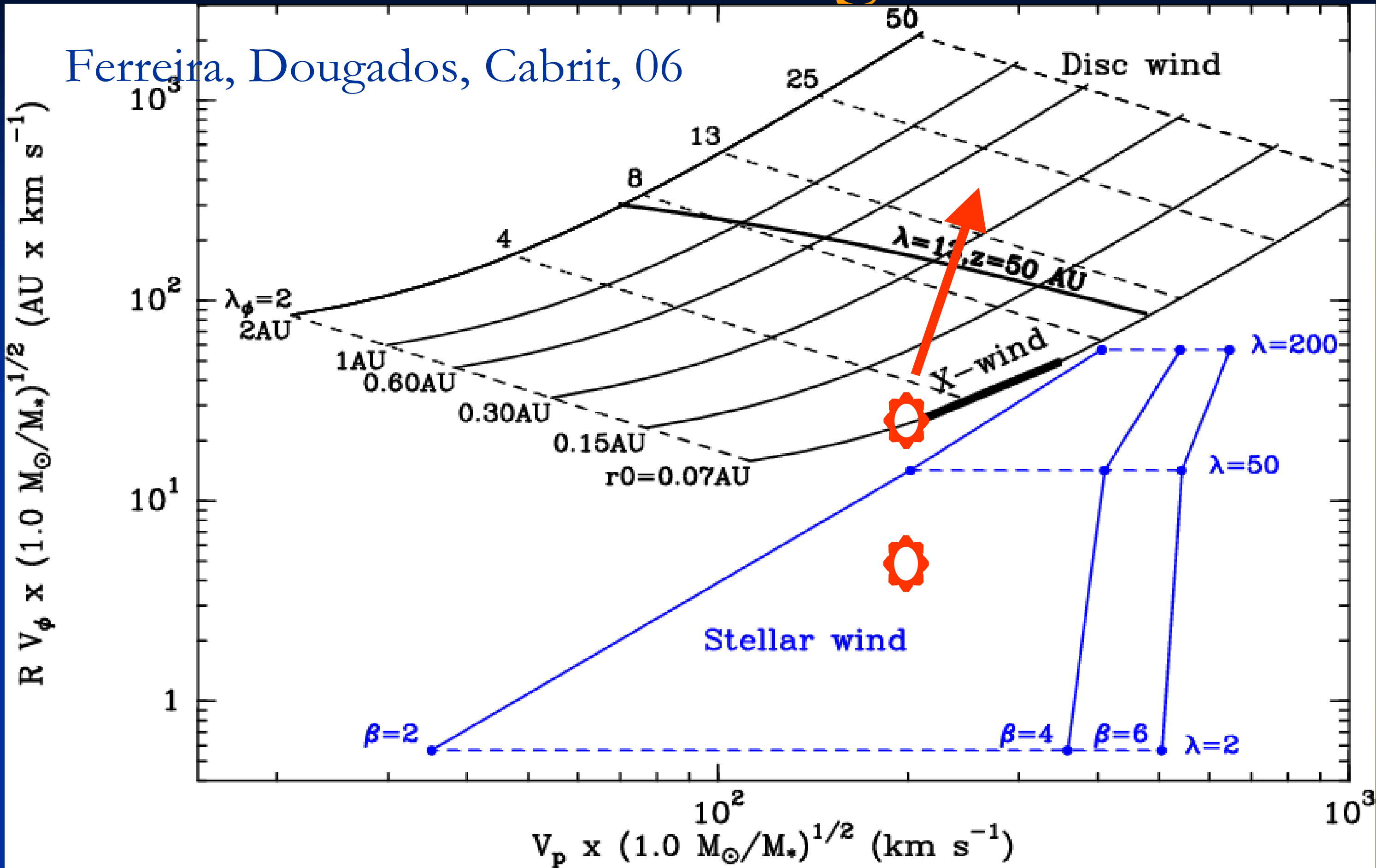
  -> synthetic map gives 10^4K







Angular Momentum

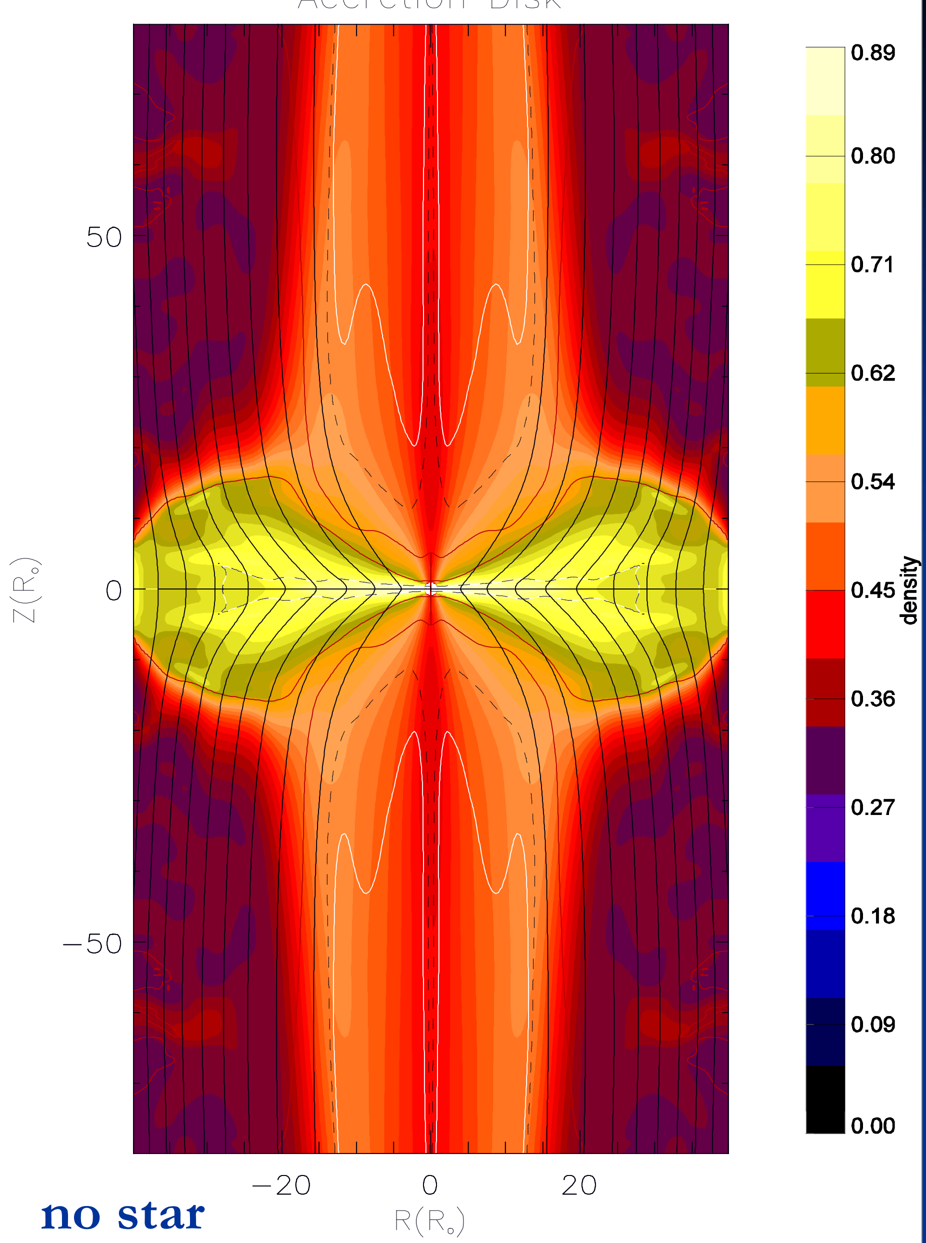


- Larger magnetic lever arm
- Small M_∞ and

$$\frac{\varpi_\infty^2}{\varpi_a^2} \geq 1$$

- Angular momentum removal:
  - $\tau = \frac{L}{\dot{J}}$ 10^7 yr for class III
- Improving solutions ?
  - See Solar wind

- Increase « λ » lever arm
  - >reduces to 10^6 yr or less
- Increases « β » P gradient
  - -> Higher Temperature



no star

Simulations

Stellar+Disk

+ turbulent viscous heating

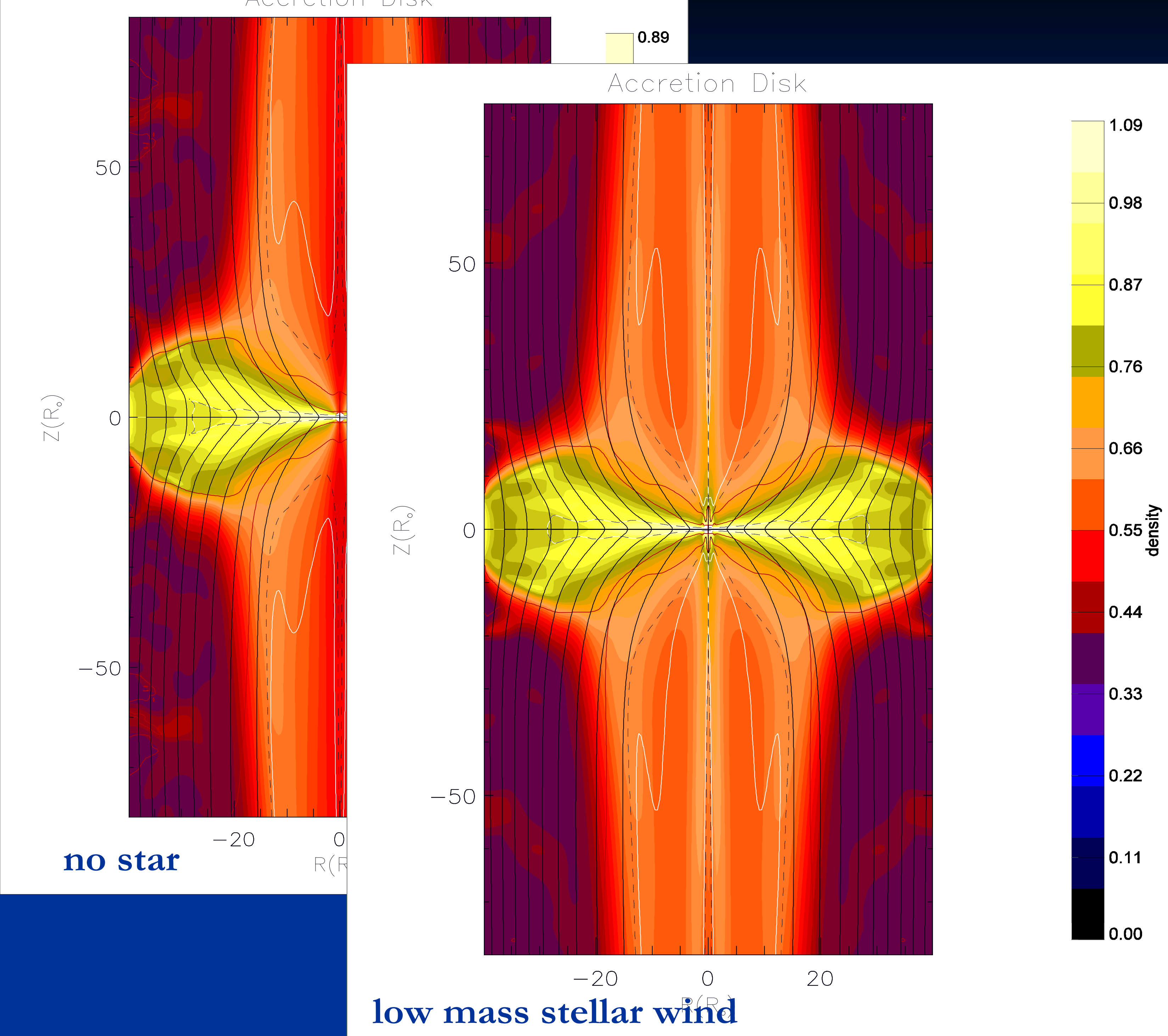
Meliani, Casse, Sauty, 2006

Increasing Wind mass loss = opens

ations

cous heating

, Sauty, 2006



Increasing Wind mass loss = opens

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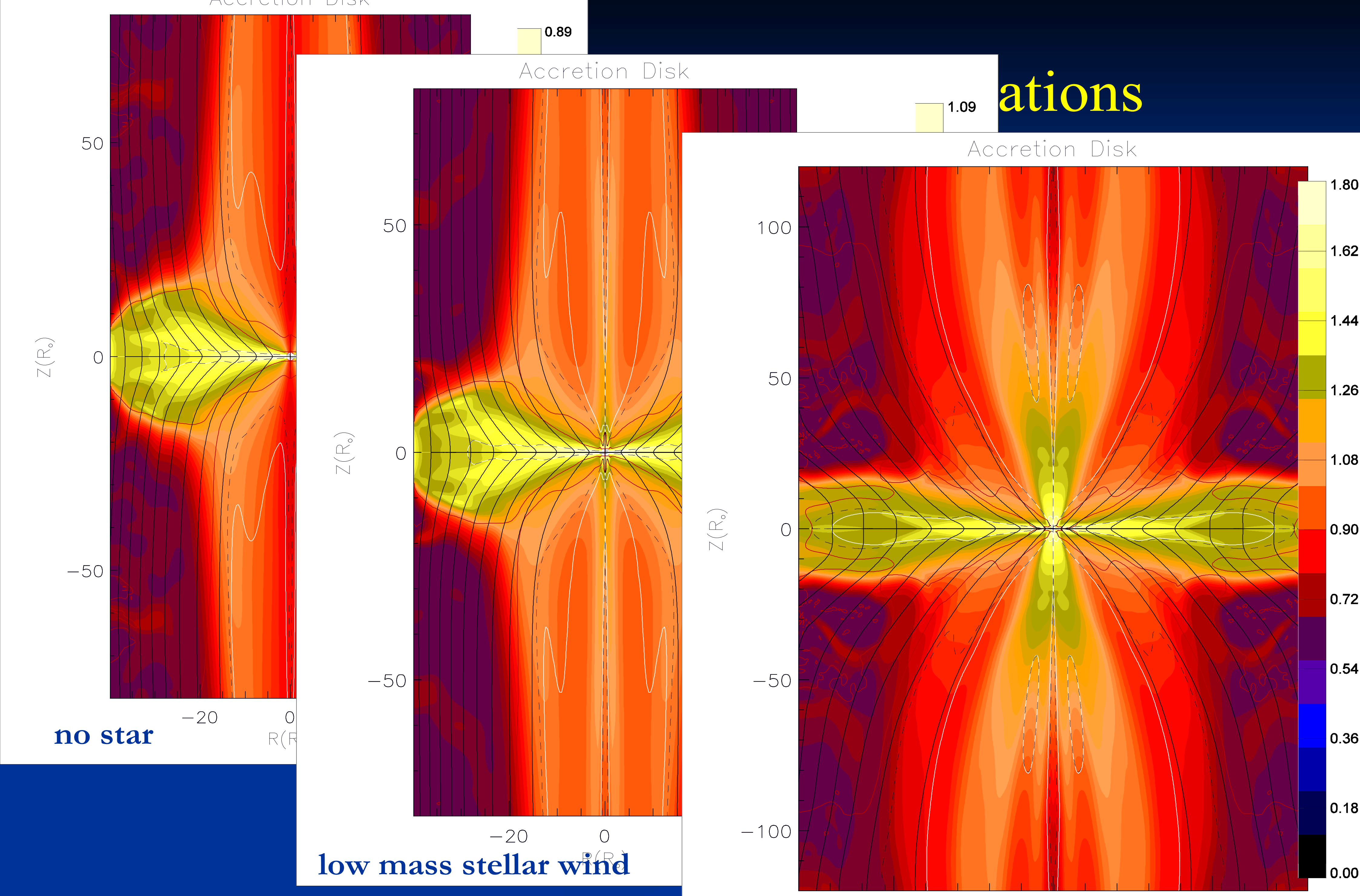
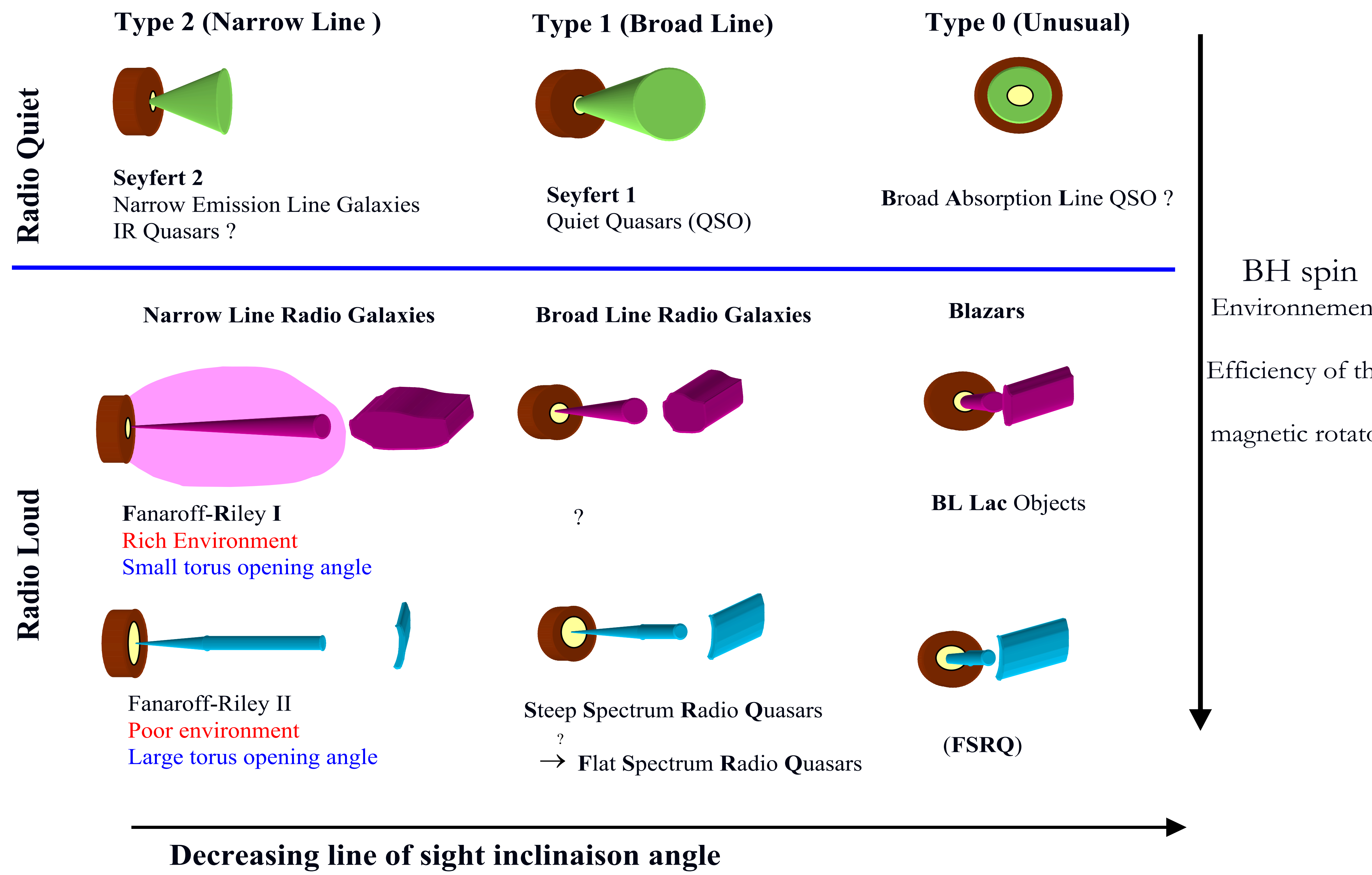


Increasing Wind mass loss = opens

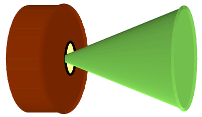
Extragalactic Winds and Jets



AGN Classification

Type 2 (Narrow Line)

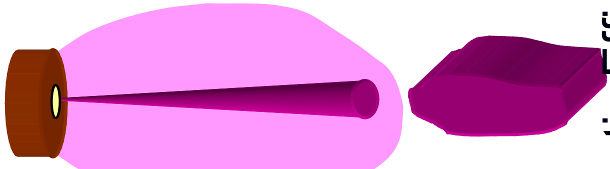
Radio Quiet



Seyfert 2
Narrow Emission Line Galaxies
IR Quasars ?

Radio Loud

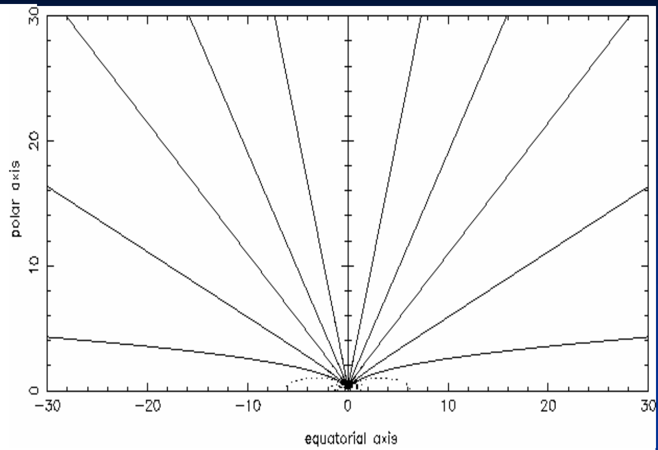
Narrow Line Radio Galaxies

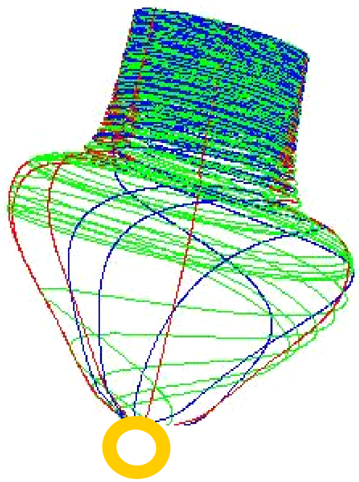


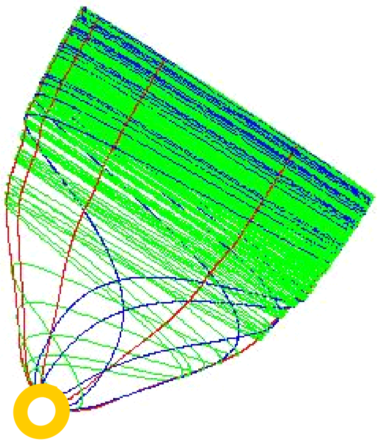
Fanaroff-**R**iley **I**
Rich Environment

Fanaroff-Riley II
Poor Environment

Magnetic Efficiency + Environment







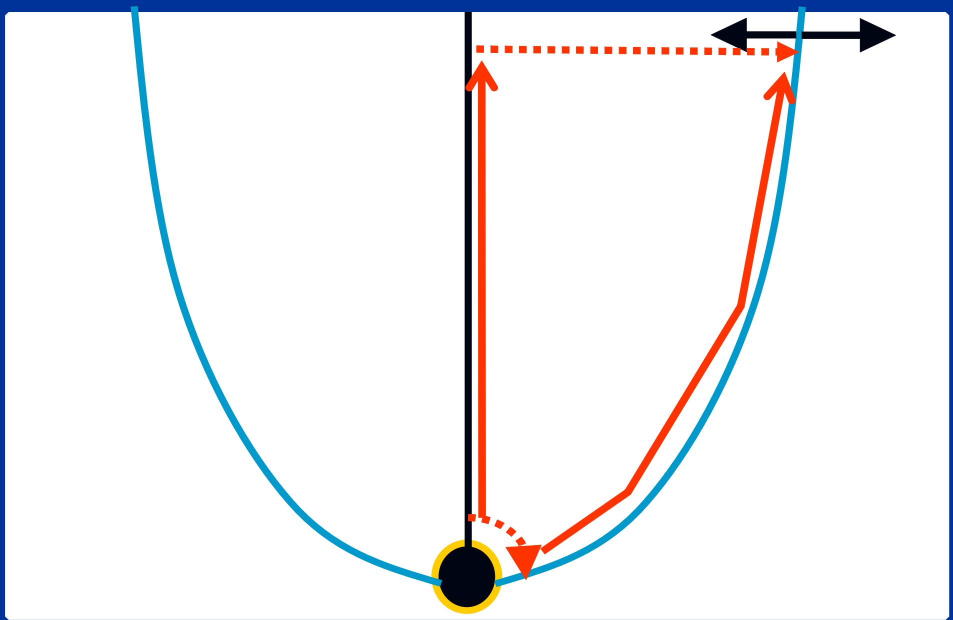
Criterion for cylindrical collimation

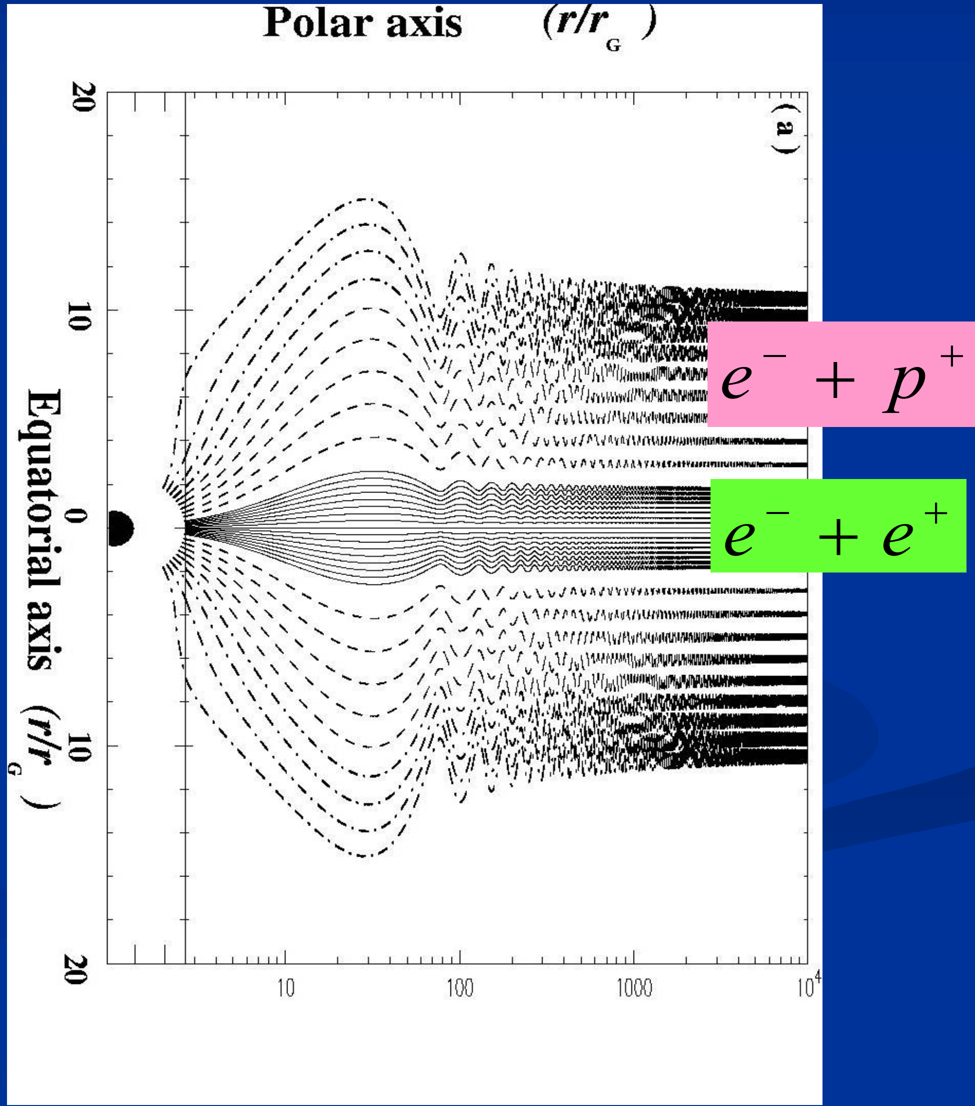
$\nabla f = f(\text{non polar line}) - f(\text{polar axis})$

$\varepsilon' \approx \nabla E$

- $\varepsilon' > 0 \mapsto$ Collimation
- $\varepsilon' < 0 \mapsto$ No Collimation

$\varepsilon' = \kappa + \varepsilon$





Criterion for cylindrical collimation

Efficiency of Pressure Confinement

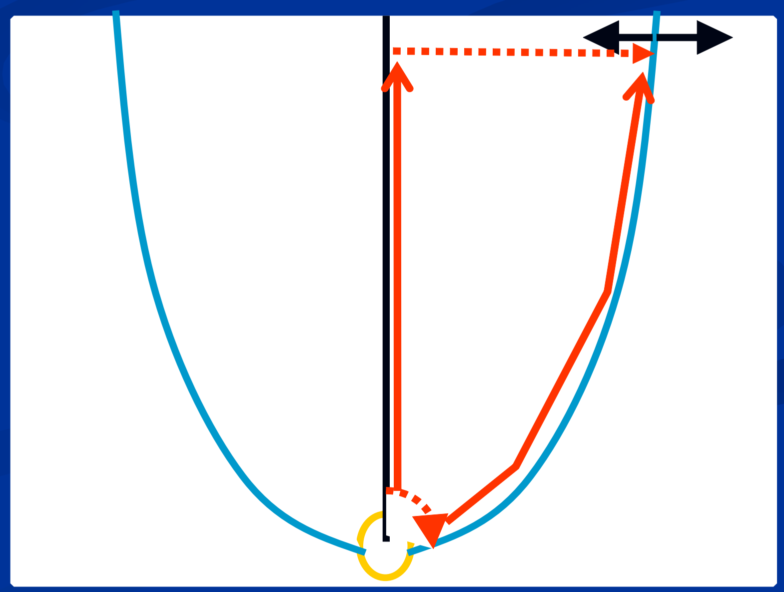
$$\kappa \propto \nabla P$$

- $\kappa>0$ Under-pressured jet
- $\kappa<0$ Over-Pressured jet

Efficiency of Magnetic Confinement

$$\frac{\varepsilon}{2\lambda^2} = \frac{E_{\mathrm{Poynting},0} + E_{\mathrm{Rot},0} - \left|\Delta E^*_{\mathrm{Grav}}\right|}{L\Omega}$$

- $E_{\mathrm{Poynting}} = L\Omega - E_{\mathrm{Rot}} \approx E_{\mathrm{MR}}$

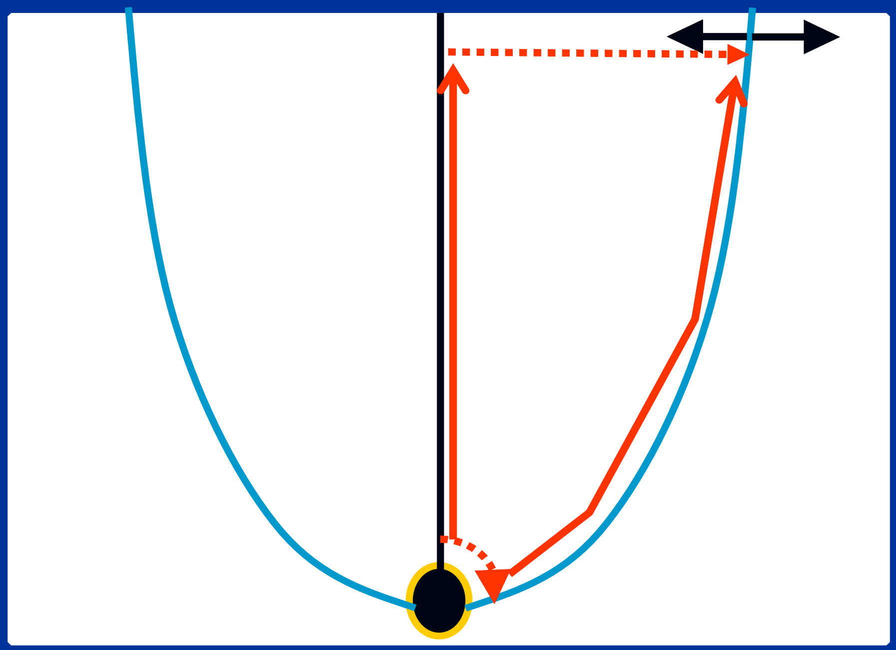


- $\varepsilon>0$ EMR
- $\varepsilon<0$ IMR

Extension to Kerr metrics

Efficiency of Magnetic Confinement

$$\frac{\varepsilon}{2\lambda^2} = \frac{E_{\mathrm{Poynting},0} + E_{\mathrm{Rot},0} - \left|\Delta E^*_{\mathrm{Grav}}\right|}{L\Omega}$$



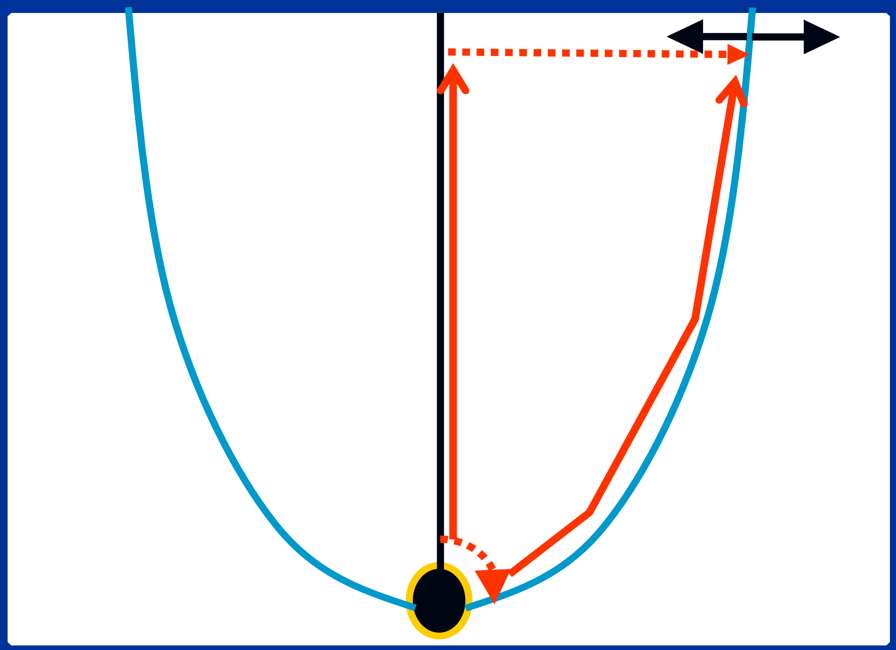
$$E_{\mathrm{Poynting}} \approx E_{\mathrm{MR}}$$

-Support lepton jets
-Efficiency of a rotating black hole in collimating

Extension to Kerr metrics

Efficiency of Magnetic Confinement

$$\frac{\varepsilon}{2\lambda^2} = \frac{E_{\text{Poynting},0} + h_0^2 E_{\text{Rot},0} - \left|\Delta E^*_{\text{Grav}}\right|}{h_0^2 L \Omega}$$



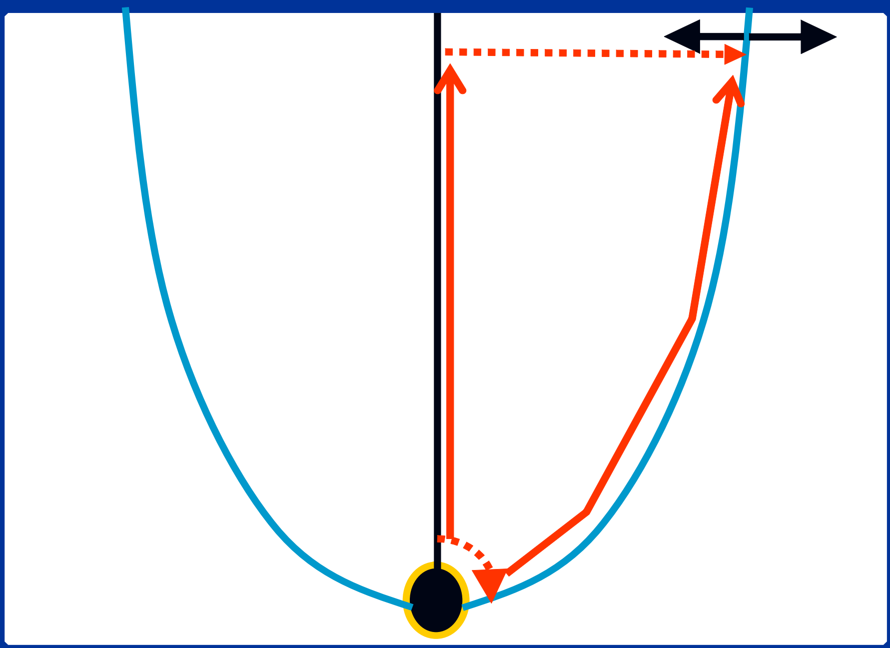
$$E_{\text{Poynting}} \approx E_{\text{MR}}$$

-Support lepton jets
-Efficiency of a rotating black hole in collimating

Extension to Kerr metrics

Efficiency of Magnetic Confinement

$$\frac{\varepsilon}{2\lambda(\lambda+\overline{\omega_*})} = \frac{E_{\mathrm{Poynting},0} - \left|\Delta E^*_{\mathrm{Grav}}\right| + h_0^2 E_{\mathrm{Rot},0} + L(\omega_0 - \omega_*)}{h_0^2 L \Omega}$$



$$E_{\mathrm{Poynting}} \approx E_{\mathrm{MR}}$$

-Support lepton jets

-Efficiency of a rotating black hole in collimating

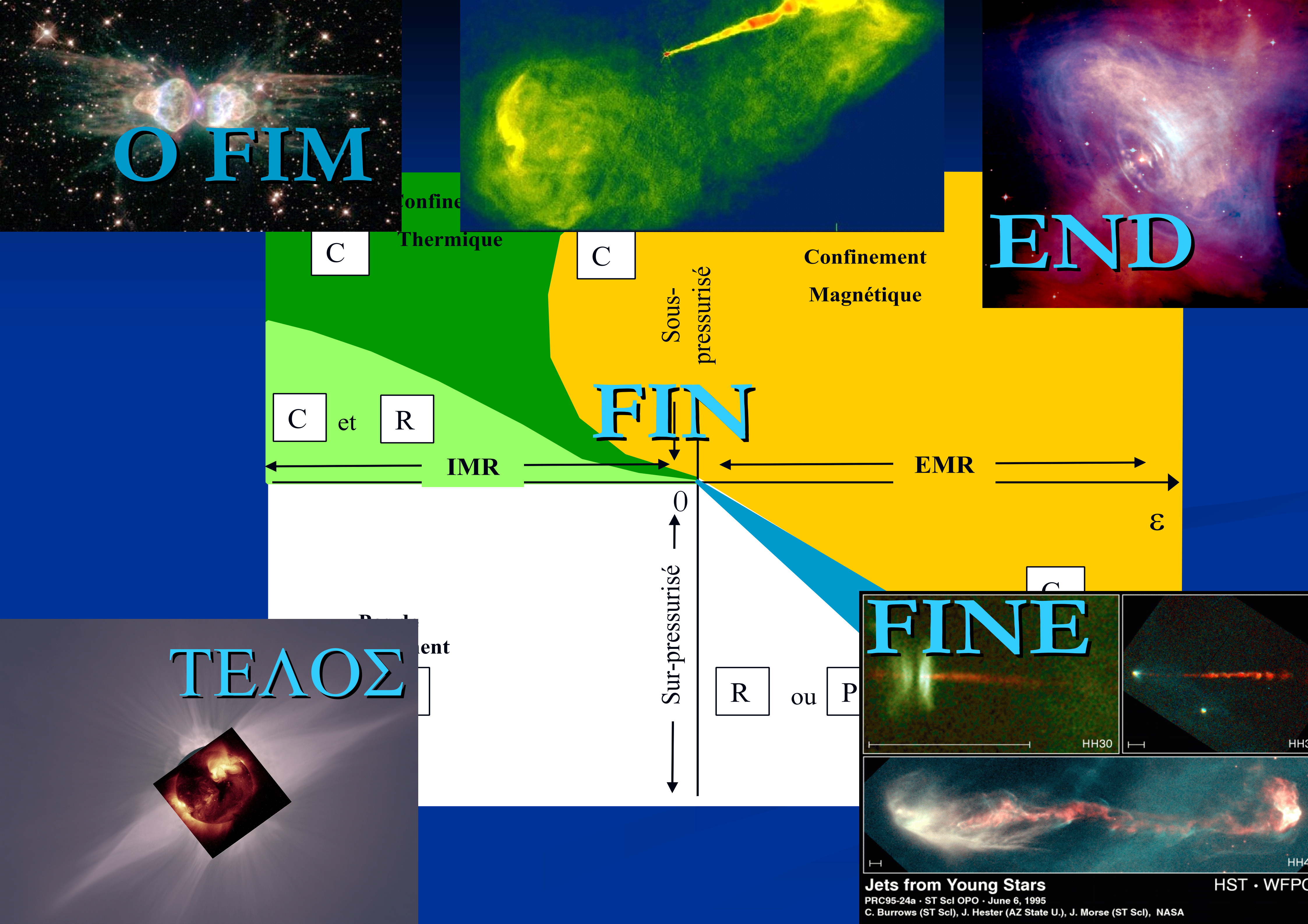
Conclusions

Stellar jets to spin down the star ? Or the inner disk itself?

Magnetic versus thermal acceleration
Proton vs positron

Black Hole Spin down <--> Stellar spin down

Rotating black hole magnetic efficiency



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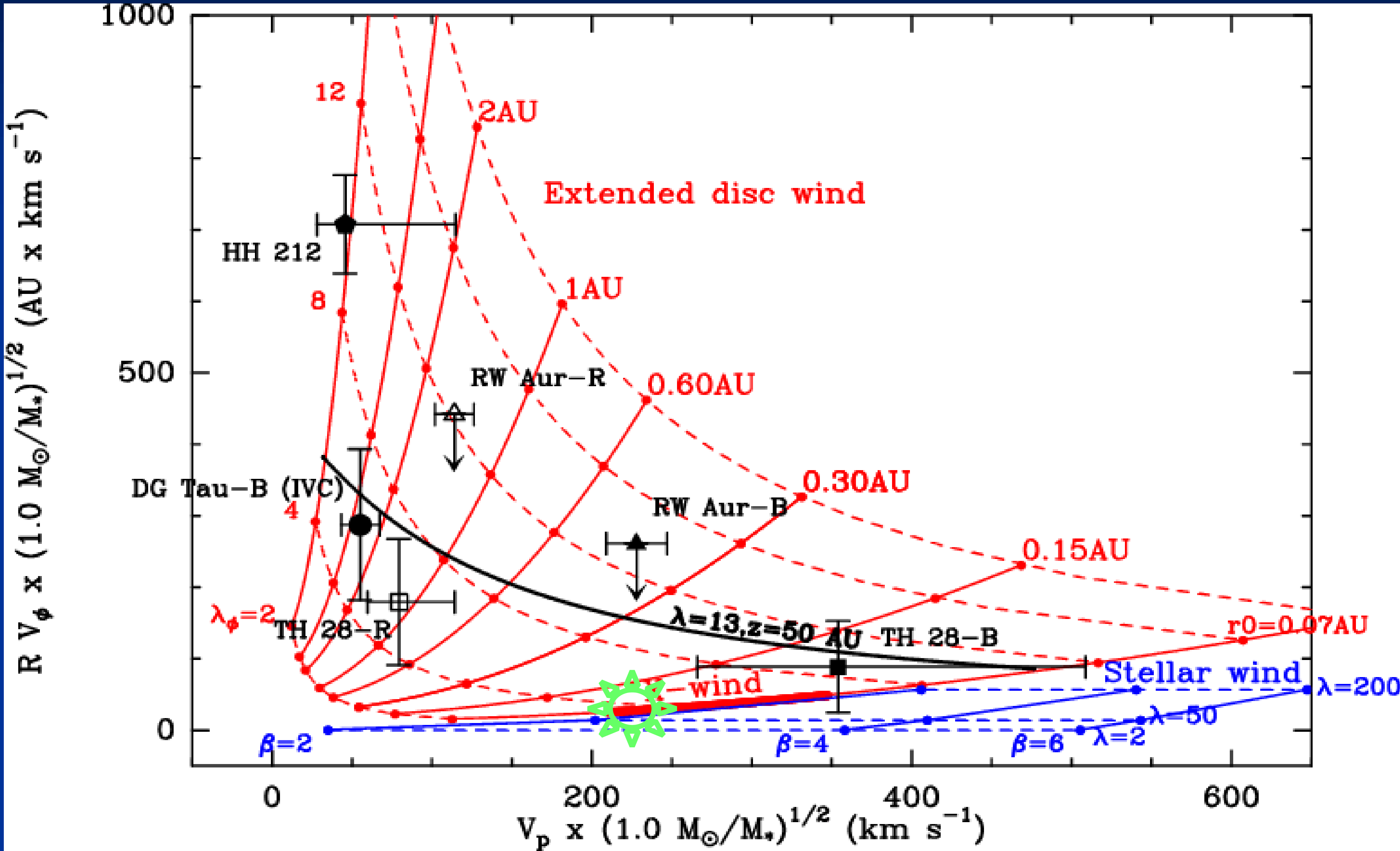
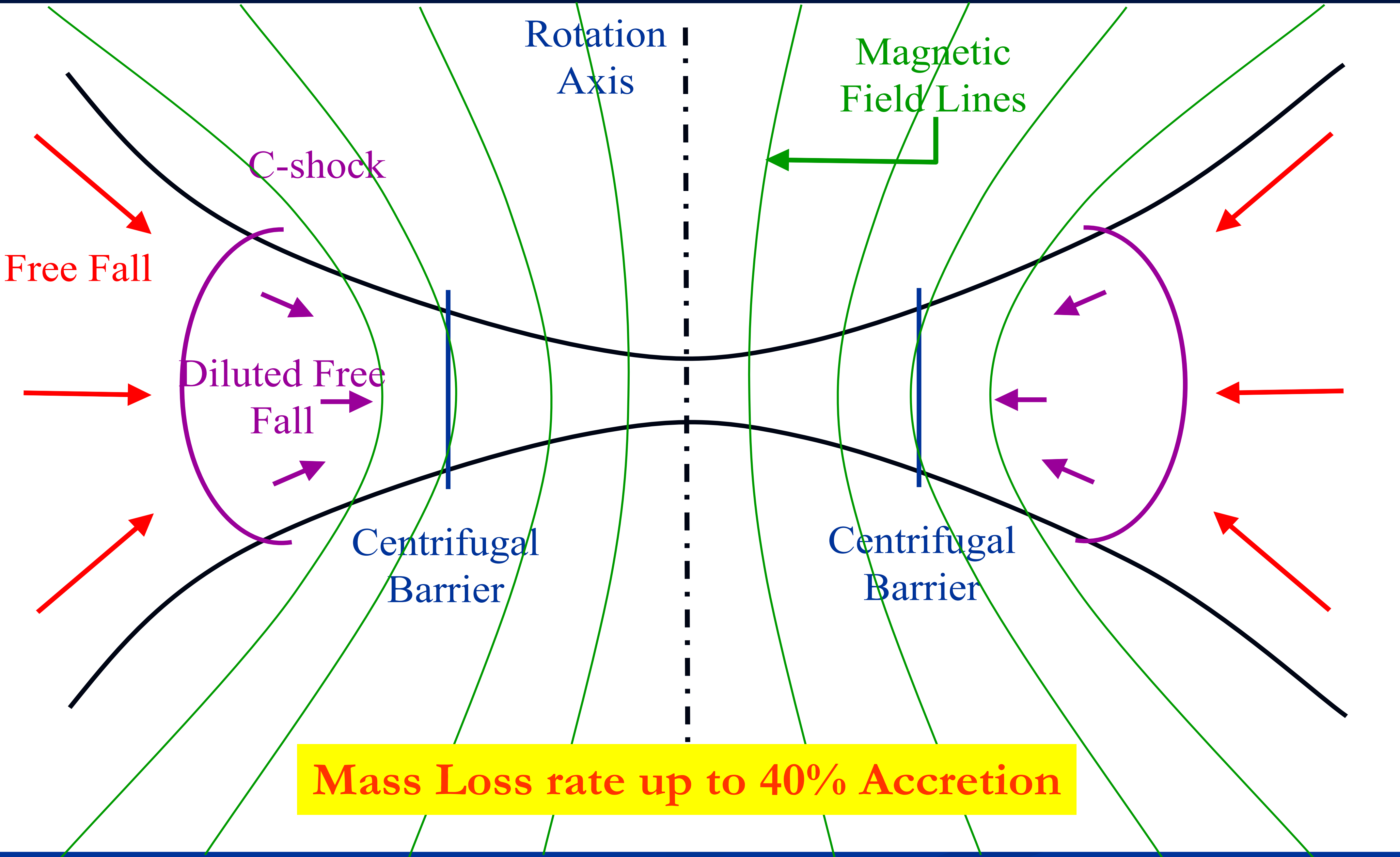
HH30
Jets from Young Stars
HST • WFPC
PRC95-24a · ST ScI OPO · June 6, 1995
C. Burrows (ST ScI), J. Hester (AZ State U.), J. Morse (ST ScI), NASA

Stellar vs disk



Disk driven Jets for Class 0: Crucial Role of Boundary Conditions



Mass Loss rate up to 40% Accretion

Contopoulos & Sauty, 2001, A&A

Alternative, cf. Henriksen et al.