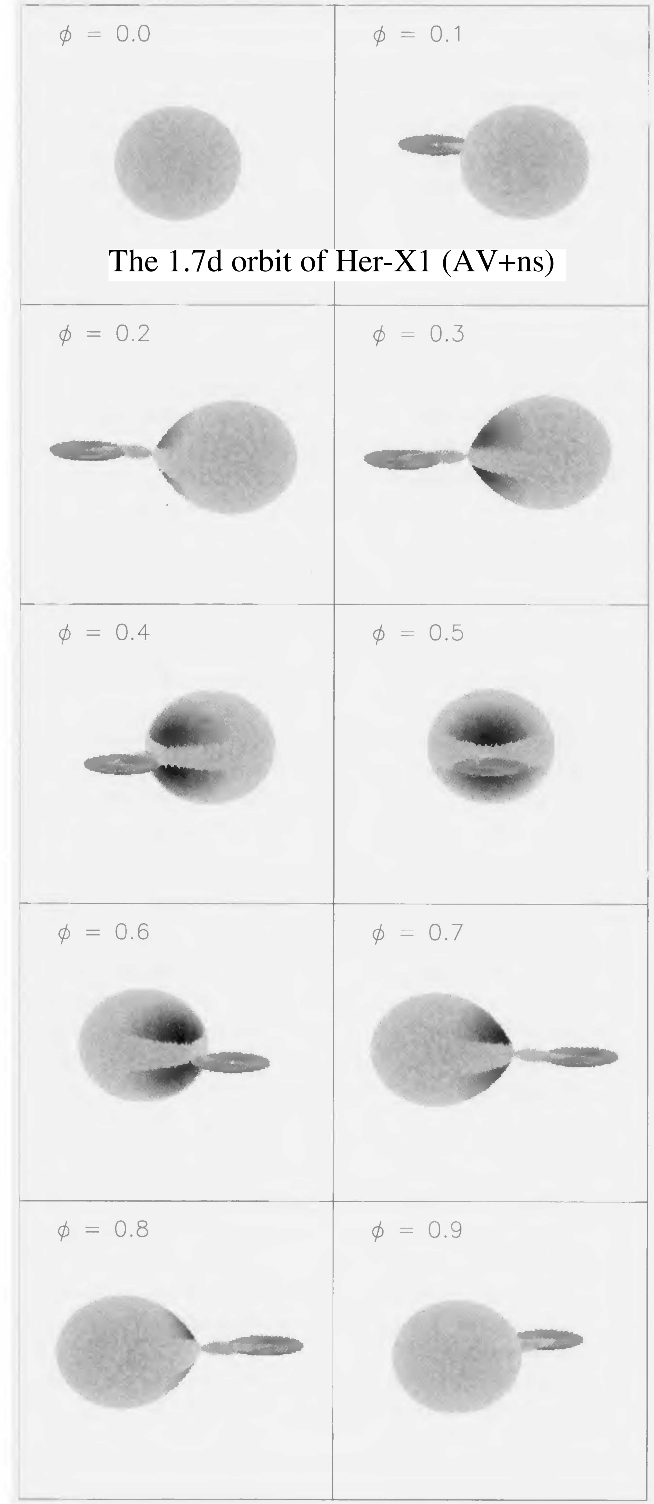
Lecture 16

Stellar Atmospheres
prof. Marcos Diaz

treasure map:

H&M: pg. 627

Frank, King and Raine 2002
"Accretion Power in Astrophysics"
pg. 84



(from Still et al. 1997)

Irradiated atmospheres

formal solution´s $I(\tau_2)$

External irradiation changes the atmosphere structure and emission

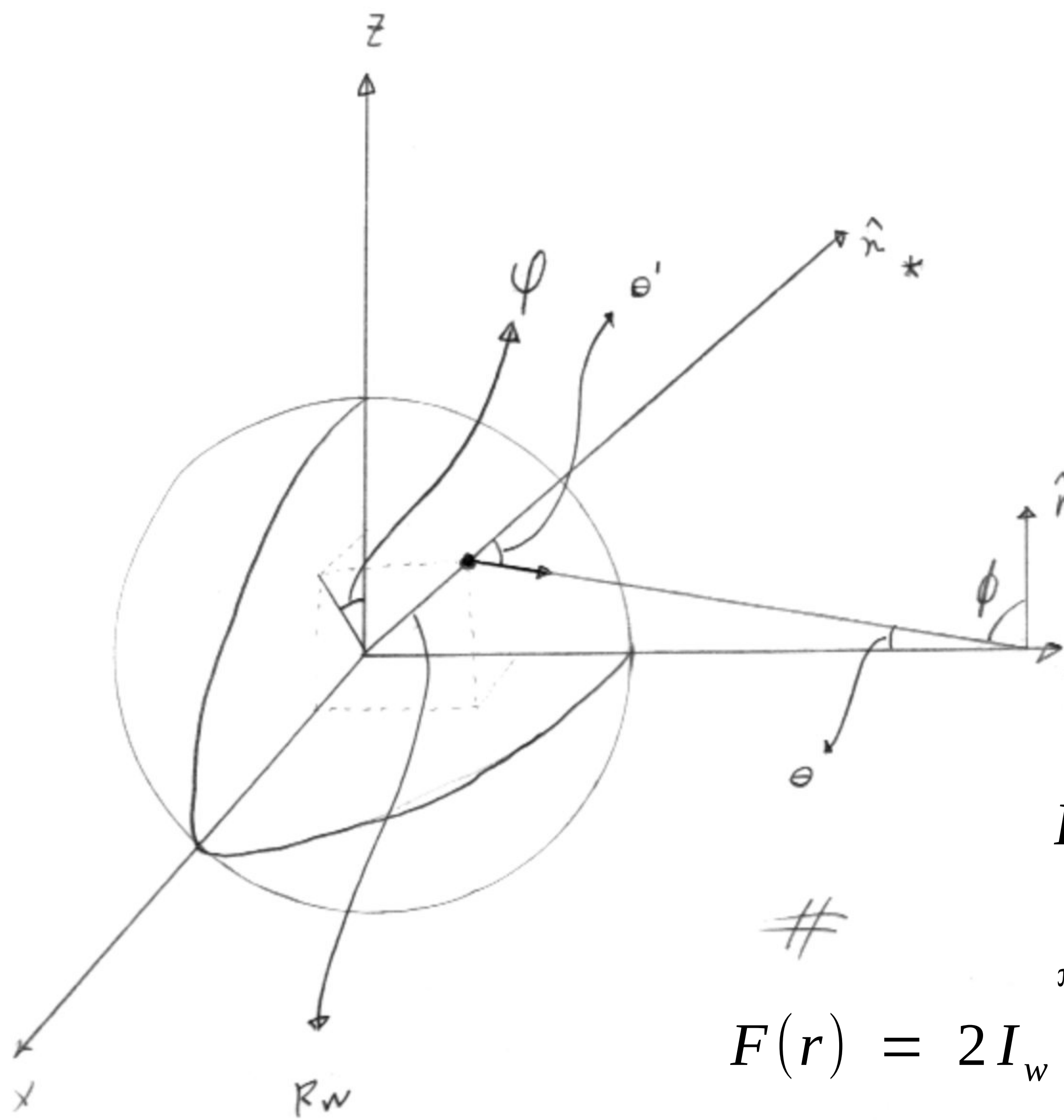
can be observed as:
- Continuum contribution
- Line Veiling
- Line reversals – emission lines

may be associated to:
- chromospheres
- mass loss
- photoionization
- comptonization

Simple model: photospheric bolometric thermalization approximation

$$\sigma T_{eff}^4 = \sigma T_{eff\,*}^4 + \phi; \qquad \phi = F(\vec{r})(1-A); \qquad \text{A = bol. albedo}$$

application: temperature profile of irradiated disks



a. $I_w(\theta') = \text{constant}$

b. $\theta_{max} = \arcsin(R_w/r)$

c. $-\pi/2 < \varphi < \pi/2$
(optically thick disk)

d. disk flare angle = 0
(geometrically thin disk)

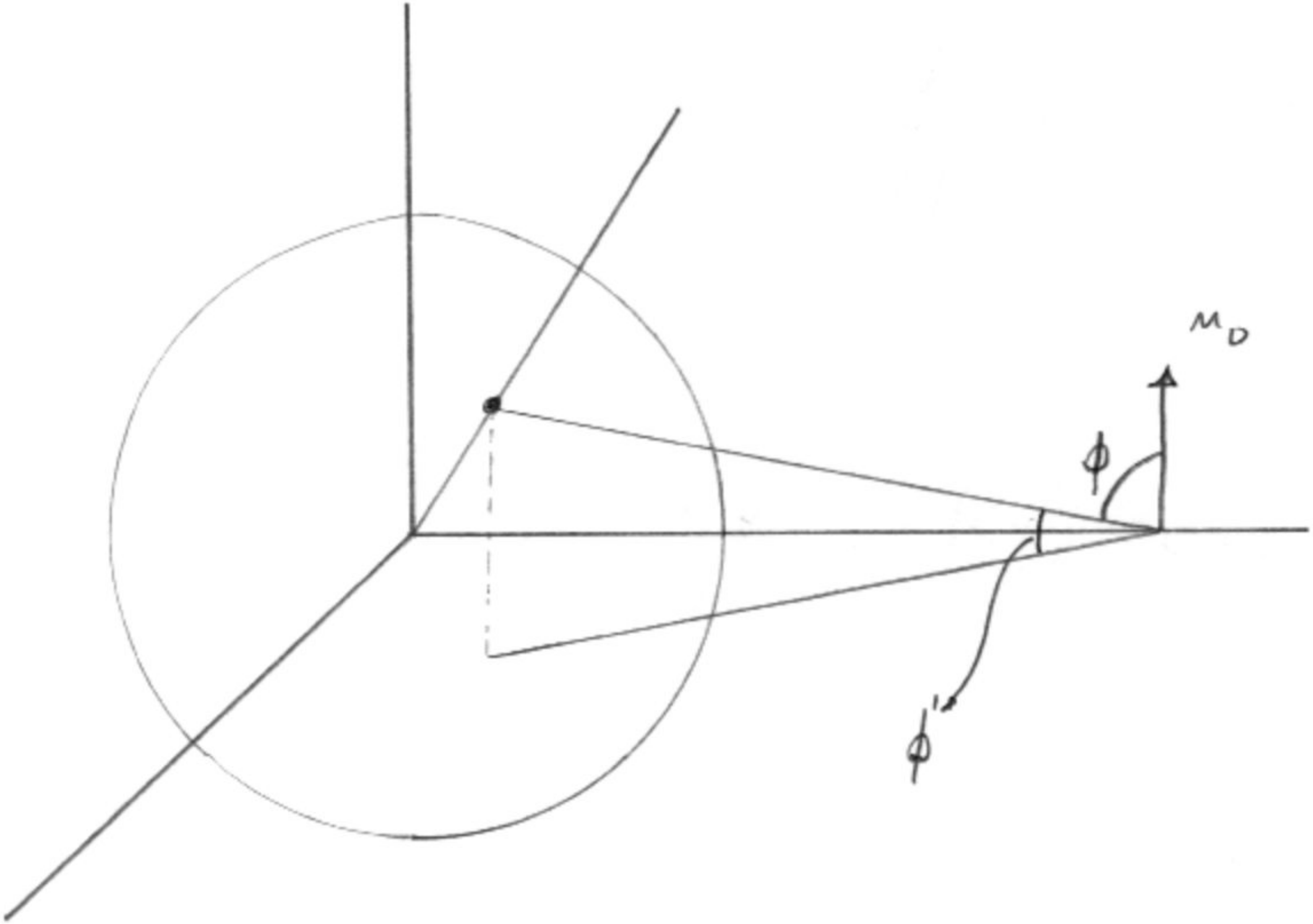
$\phi \neq 90 - \theta$

$$F(r) = \int_w \vec{I} \cdot \hat{n_D}\, d\Omega$$

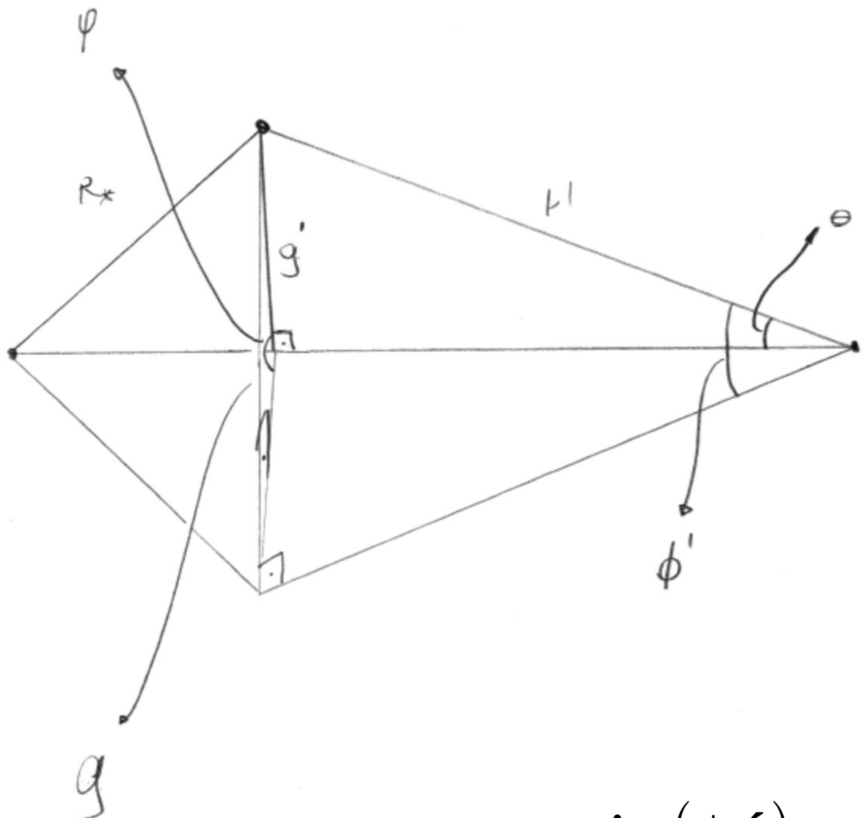
#

$$F(r) = 2 I_w \int_o^{\pi/2} \int_0^{\theta_{max}} \cos(\phi) \sin(\theta)\, d\theta\, d\varphi$$

$\phi' = 90 - \phi$



$$F(r) = 2 I_w \int_o^{\pi/2} \int_0^{\theta_{max}} \sin(\phi') \sin(\theta)\, d\theta\, d\varphi$$



$$\sin(\phi') = \frac{g}{r'}$$

$$\sin(\theta) = \frac{g'}{r'}$$

$$\sin(\varphi) = \frac{g}{g'}$$

$$\sin(\phi') = \frac{\sin(\varphi) g'}{r'} = \sin(\varphi)\sin(\theta)$$

$$F(r) = 2 I_w \int_o^{\pi/2} \int_0^{\theta_{max}} \sin(\varphi)\sin^2(\theta)\, d\theta\, d\varphi = 2 I_w \int_0^{\theta_{max}} \sin^2(\theta)\, d\theta$$

$$F(r) = 2I_w\left[\frac{\theta_{max}}{2} - \frac{1}{4}\sin(2\theta_{max})\right] = I_w\left[\theta_{max} - \sin(\theta_{max})\cos(\theta_{max})\right]$$

$$F(r) = I_w\left[\arcsin\left(\frac{R_w}{r}\right) - \frac{R_w}{r}\cos\left(\arcsin\left(\frac{R_w}{r}\right)\right)\right]$$

$$F(r) = I_w\left[\arcsin\left(\frac{R_w}{r}\right) - \frac{R_w}{r}\left(1 - \left(\frac{R_w}{r}\right)^2\right)^{1/2}\right] = \frac{\sigma T_{eff}^4(r)}{(1-A)}$$

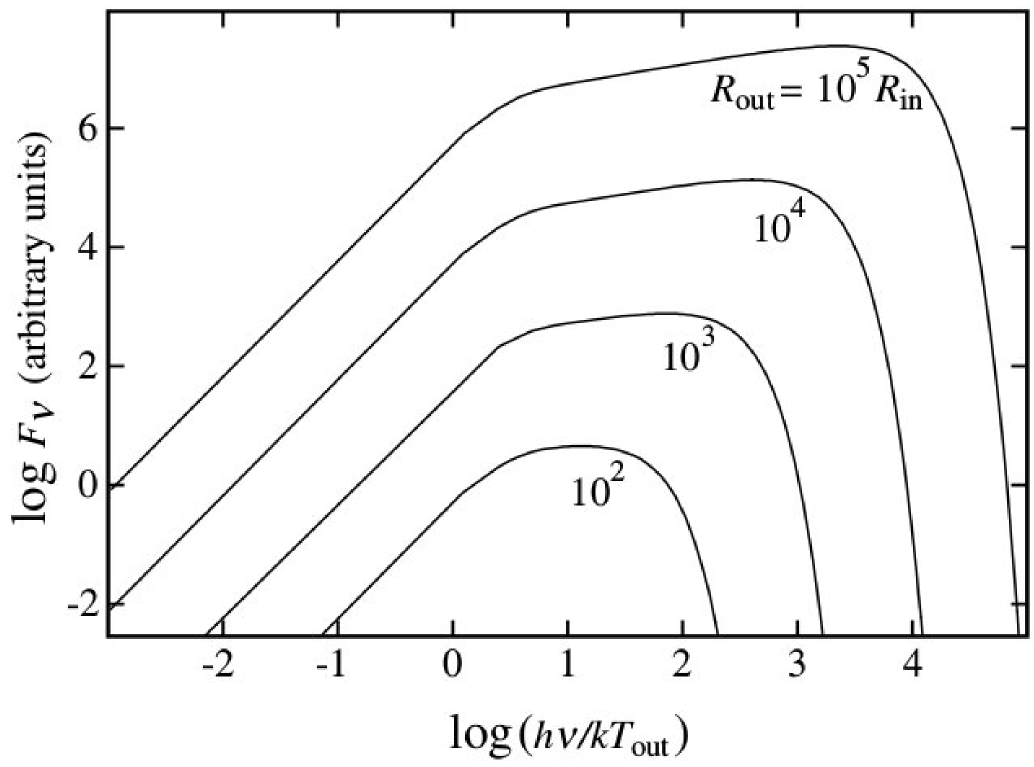
$$F(R_w) = \pi I_w/2$$

$$F(\infty) = 0$$

r >> R_w → $F(r) \approx constant . D_{viscous}$

$$D_{viscous}(r) = \frac{3GM_w\dot{M}}{8\pi r^3}\left[1-\left(\frac{R_w}{r}\right)^{1/2}\right]$$

standard Shakura & Sunyaev α-disk



(from Frank, King & Raine 2002)