天文學一

Binaryl

pc

- pc: 近太陽系天體
- kpc: 銀河系內
- mpc: 河系間

天球座標

星等

消光

$$I_{out} = \frac{I_{in}}{\lambda^4}$$

Binary

$$M_A + M_B = \frac{a_{au}^3}{P_y^2}$$

Geometry of an Orbit

JD/MJD

Binary Mass Function

$$\frac{M^3(\sin i)^3}{(M+m)^2} = \frac{Tv_0^3}{2\pi G}$$

in circular orbit

T、v_0 已知，$\frac{Tv_0^3}{2\pi G} = \text{constant}$

$$\frac{M^3(\sin i)^3}{(M+m)^2} < \frac{M^3}{(M+m)^2} < \frac{M^3}{M^2} = M$$

$$M > \frac{Tv_0^3}{2\pi G}$$

Accretion

$$L = \frac{GM}{R}\frac{dm}{dt} = \eta\frac{dm}{dt}c^2$$

Eddington Limit

$$L_{edd} = 1.26 \times 10^{38}\left(\frac{M}{M_\odot}\right) erg/s = 3.2 \times^4 \left(\frac{M}{M_\odot}\right) L_\odot$$

BinaryII

Stellar Evolution

Stellar Classification

OBAFGKM
0->9

Roche Lobe

High-Mass X-ray Binary

- 大部分都是
- 亮
- 緻密星體+大質量恆星
- 年輕（因為大質量）
- orbit: days to years
- 大偏心率

伴星（大質量恆星）

- O、B
- $M > 10M_\odot$
- 強恆星風

Wind-fed accretion

- 相對 Roche-lobe 小

Periastron Flaring Activities

- 緻密星體穿過吸積盤

Low-Mass X-ray Binary

- 暗
- 週期短 < 1 天

- 軌道圓
- 古老
- 潮汐鎖定

e << 1

$$t_{sync} \approx 10^4 \frac{1+q}{2q} P_{orb}^4 \text{ year}$$

$$t_{circ} \approx \frac{10^6}{q} \left(\frac{1+q}{2} \right)^{5/3} P_{orb}^{16/3} \text{ year}$$

伴星

- G、M
- 約等於太陽
- 弱恆星風 $\approx 10^{-14} M_\odot$
- Roche lobe overflow $\approx 10^{-8} M_\odot \approx 100\%$

Binary Black Hole

- Inspiral
- Merger
- Ringdown

White Dwarf

Helium Flash

- low mass star < 2.3 $M_\odot$
- degenerate
- 3He -> C + 2γ

Planetary Nebulae

white dwarf

- radius ≈ earth
- mass ≈ sun
- T = 10000K

變星

- LMXB
- 強磁場

- 磁力更強會沒有吸積 -> polars

novae

- transient
- 重複發生
- 大質量粉塵潰堤撞到白矮星

Chandrasekhar Limit

- $1.4M_{\odot}$

Type Ia Supernovae

- 白矮星炸掉
- 內部壓力大到 C 和 O 聚變
- 兩顆合併或是一顆吸超過 Chandrasekhar Limit
- standard candle
  - slow 1a supernovae -> more luminous
  - fast 1a supernovae -> less luminous

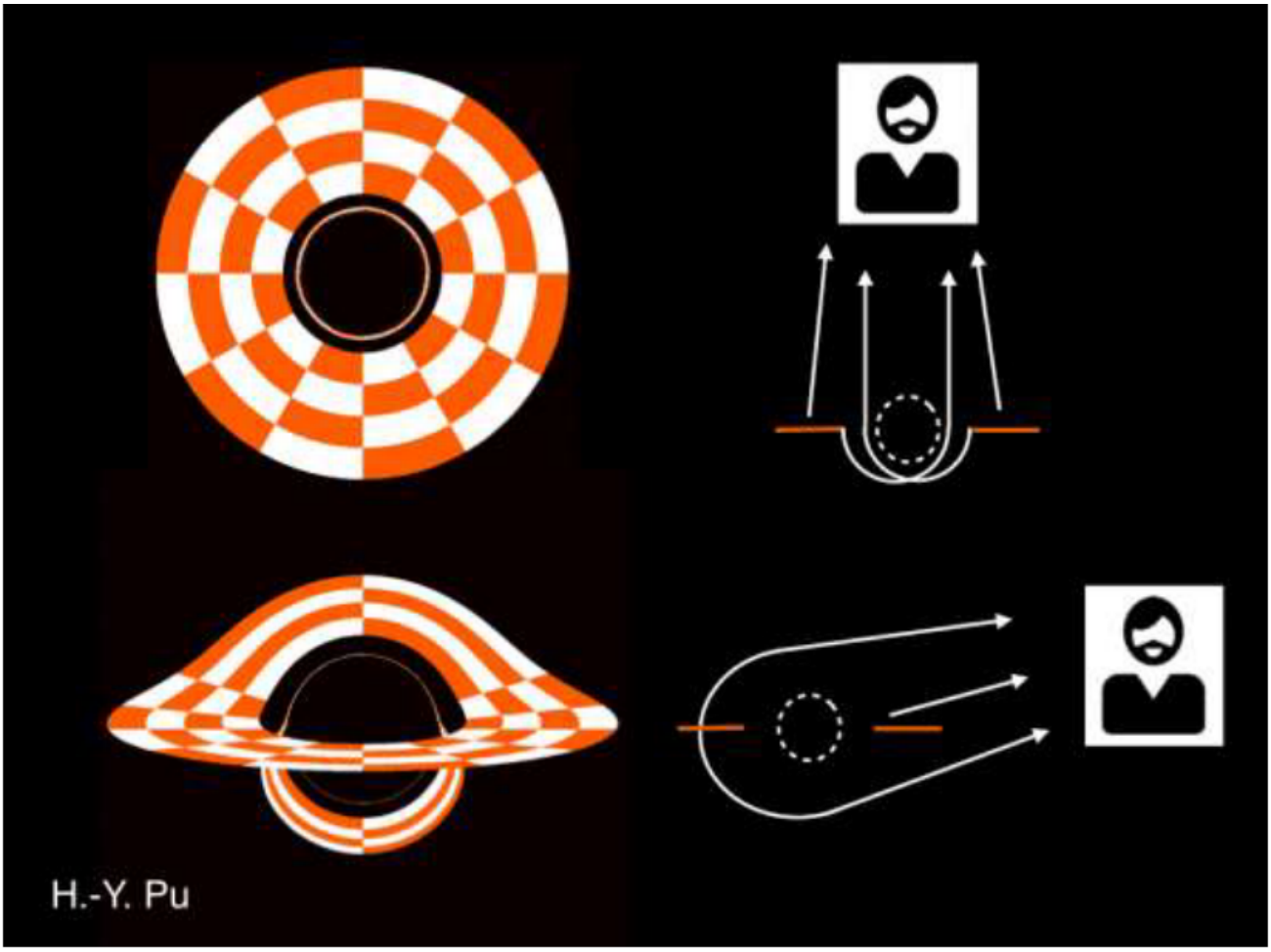
Black Dwarf

Black Hole

Schwarzschild Radius

- event horizon
- $R = \frac{2GM}{c^2}$

Black hole shadow



Spaghettification

- 潮汐力

Supermassive black holes

- burn from black hole merger
- $4 \times 10^6 M_\odot$

Bondi accretion

黑洞穿越星際塵埃
$\dot{M} \approx \pi R_b^2 \rho v$

Tidal Disruption Events

黑洞撕裂星體
$\Delta g = GM\left(\frac{2r}{R^3}\right)$

Ultraluminous X-ray sources

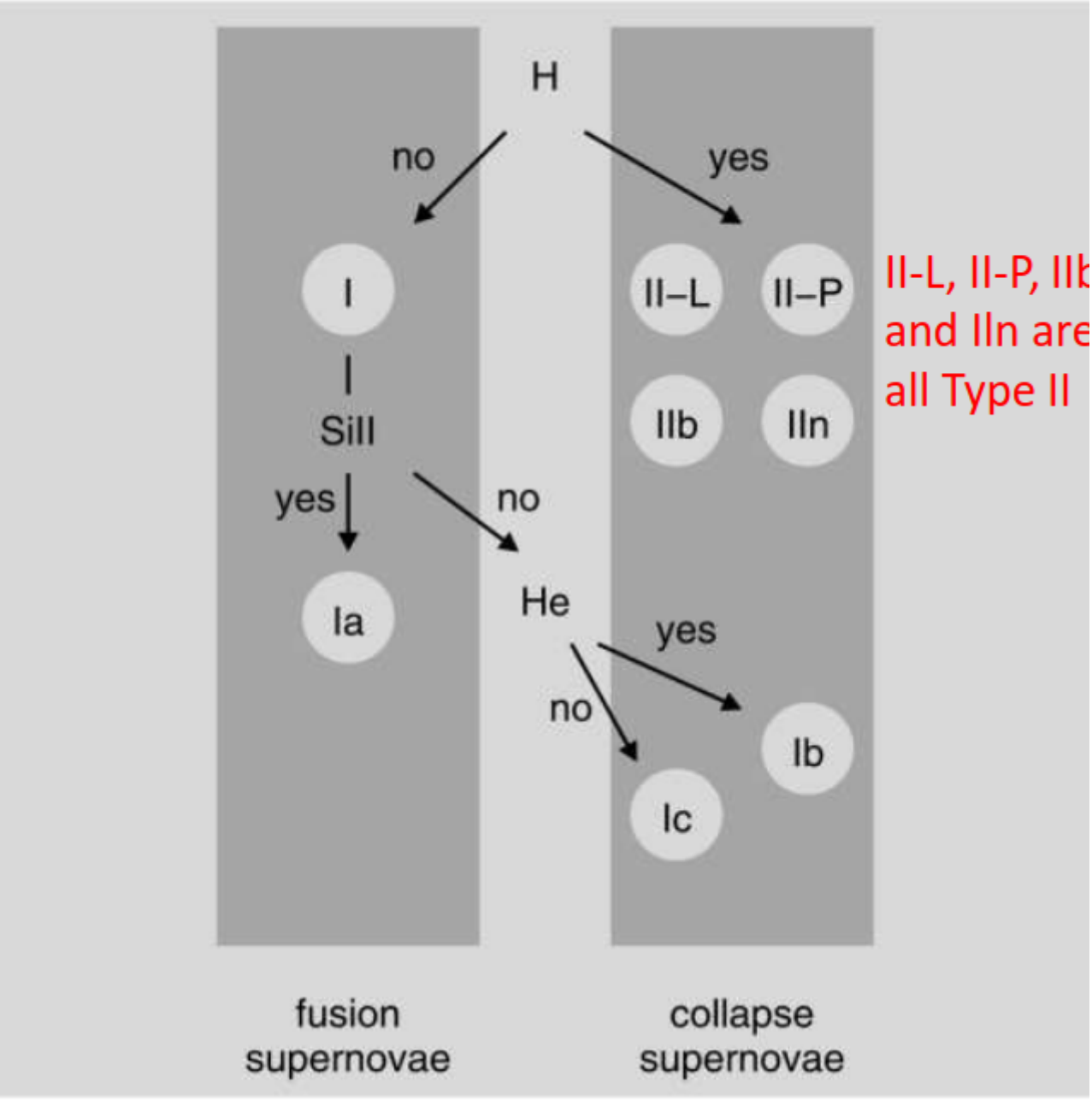
- 銀河系外
- 平均每個河系 1~2 個

High-Energy Astronomy

各種天文望遠鏡

Transient

supernovae



Core-collapse supernovae

- H > He > C > Ne > O > Si >>>>> F
- 全部燒完後因為重力坍塌、爆炸

Photodisintegration

- Fe + γ -> 13 He
- He + $gamma$ -> 2p^++2n
- 吸能量
- gamma come from black body radiation
- p+e -> n
- n 累積
- 如果中子簡併力撐住 -> 中子星
- 否 -> 黑洞

Lensing Effect

$$\theta_{\pm} = \frac{1}{2}\left(\frac{x}{D} \pm \sqrt{\frac{x^2}{D} + 4\beta^2}\right)$$

magnification

$$q = \frac{l}{x}\frac{1 + \frac{x^2}{2l^2}}{\left(1 + \frac{x^2}{4l^2}\right)^2}$$

$$l = \sqrt{\alpha_0 D R_0}$$