青年学者学术交流活动

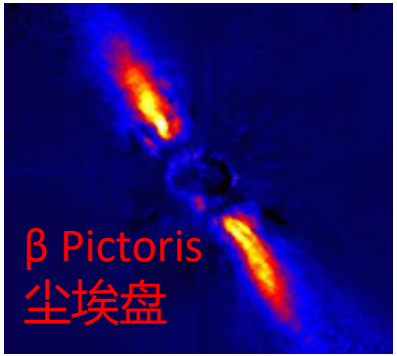
星际消光、尘埃及其深度应用

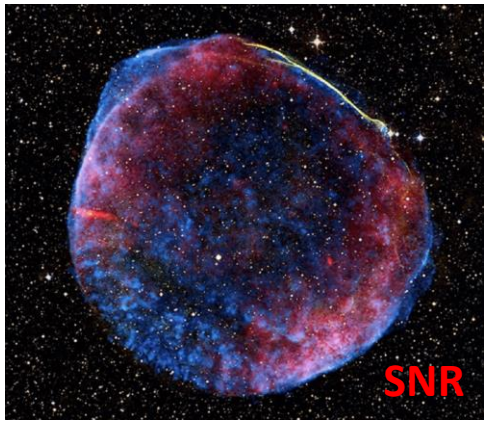
王舒

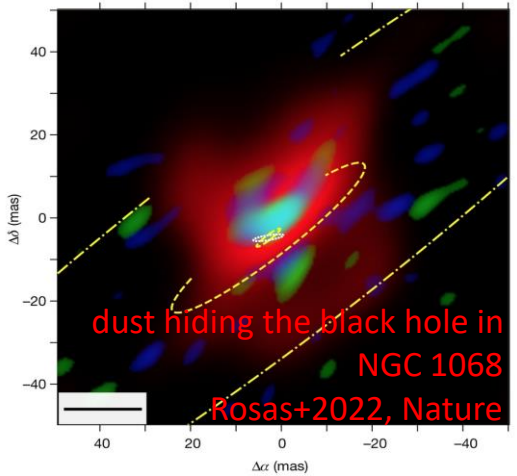
光学部--银河系三维结构研究团组

星际尘埃消光

- 星际尘埃广泛存在于各种天体环境
- 尘埃深刻地影响天体物理的几乎所有过程







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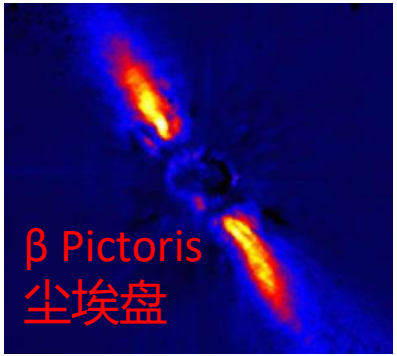
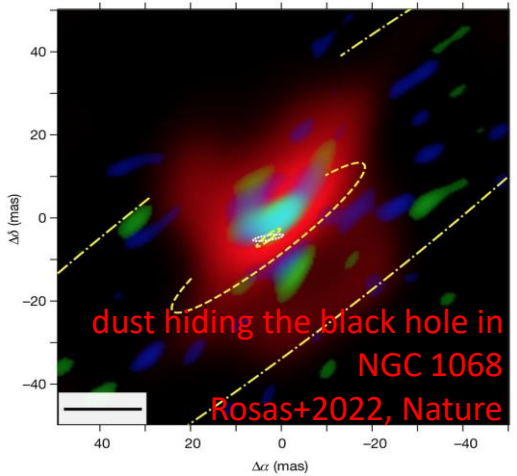
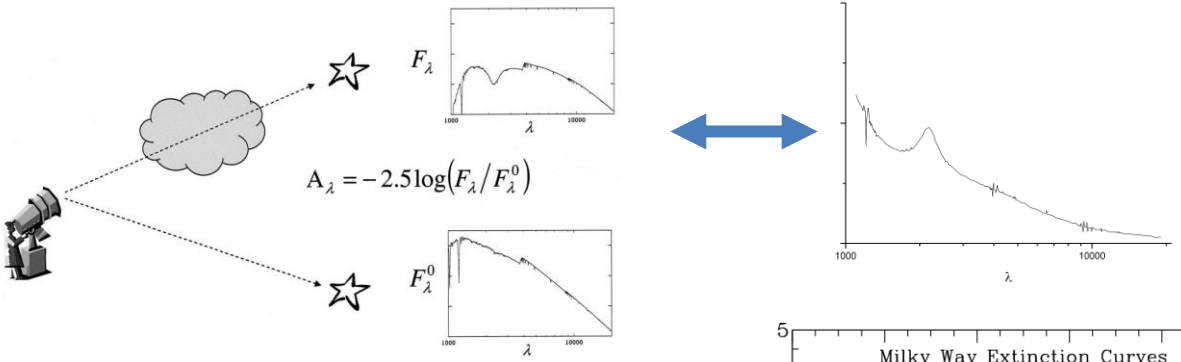
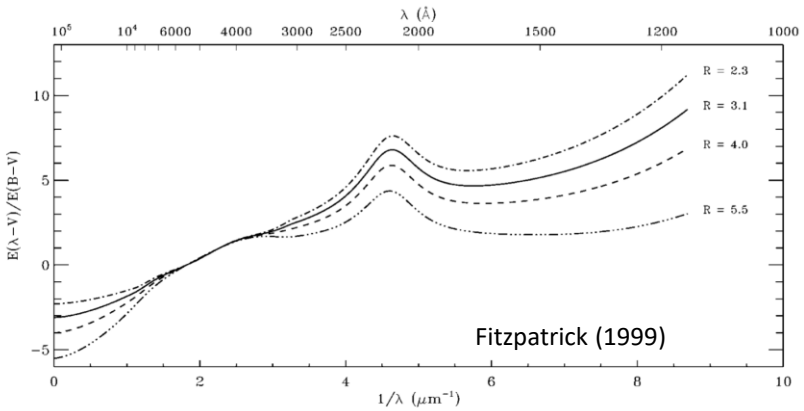
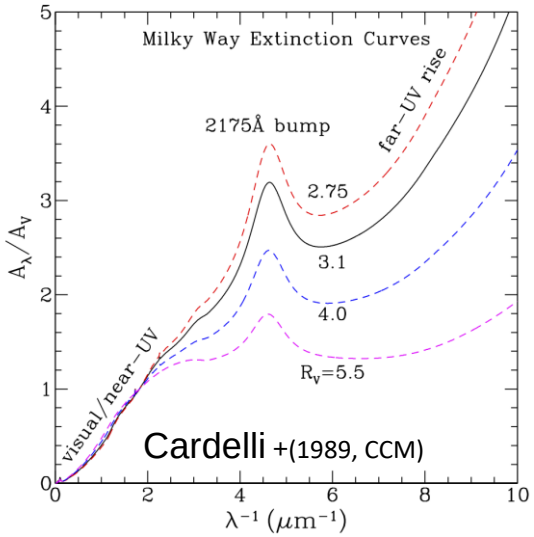




星际消光规律







- 银河系消光

$$R_V = \frac{A_V}{A_B - A_V} = \frac{A_V}{E(B-V)}$$

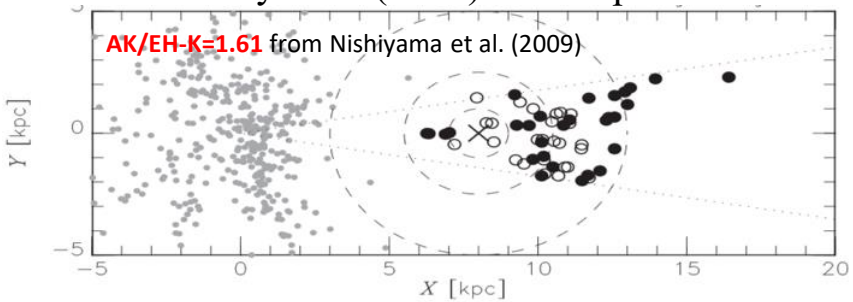
- 平均消光曲线 R_V=3.1

消光改正→需要高精度消光规律

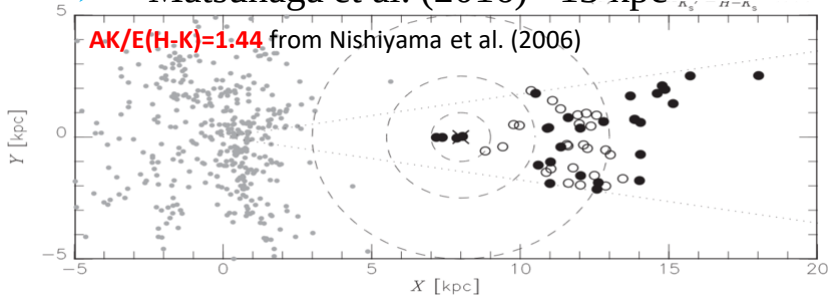
消光影响距离测定

造父变星距离

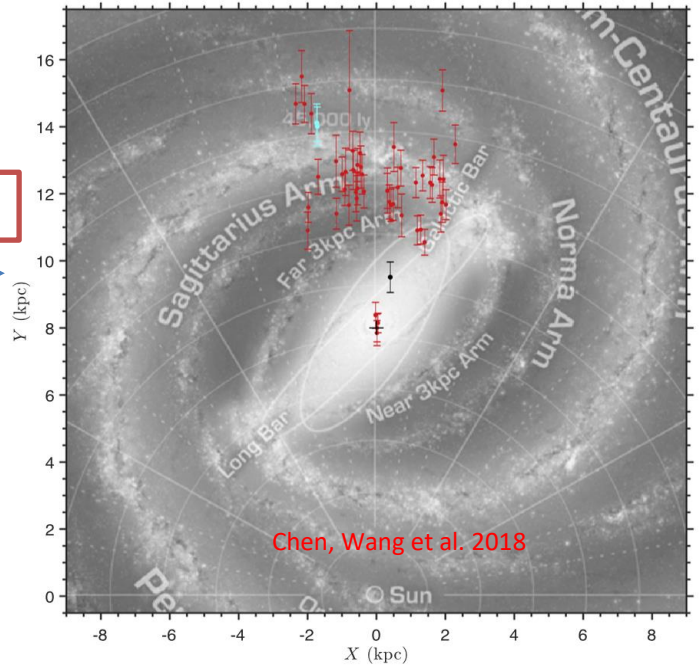
- Dékány et al. (2015): ~ 9.5 kpc



- Matsunaga et al. (2016)~ 13 kpc



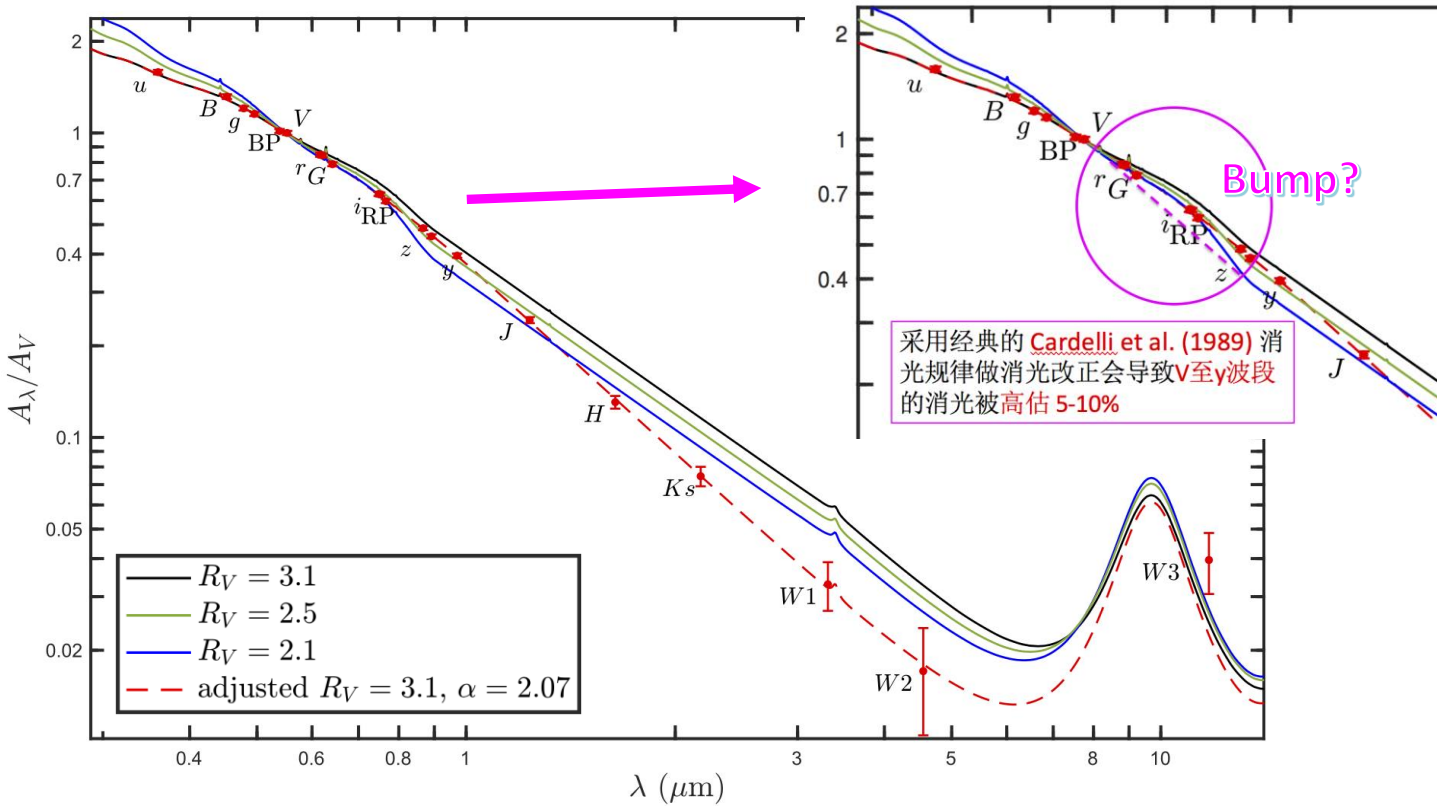
消光改正



4kpc的距离偏差完全来自采用的消光规律！

更新经典消光规律

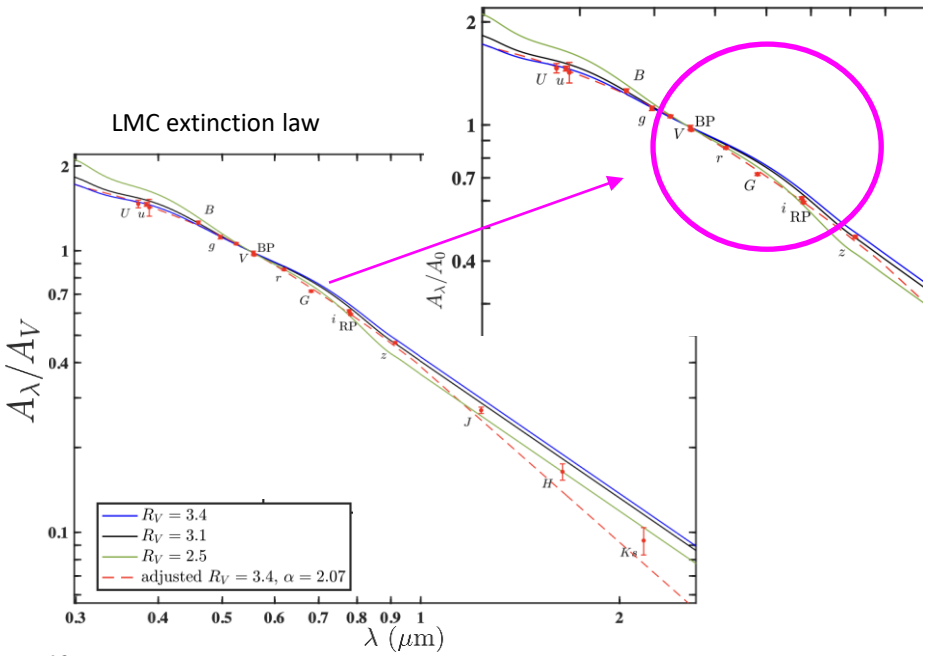
高精度: 误差 < 2.5%
时代的需要

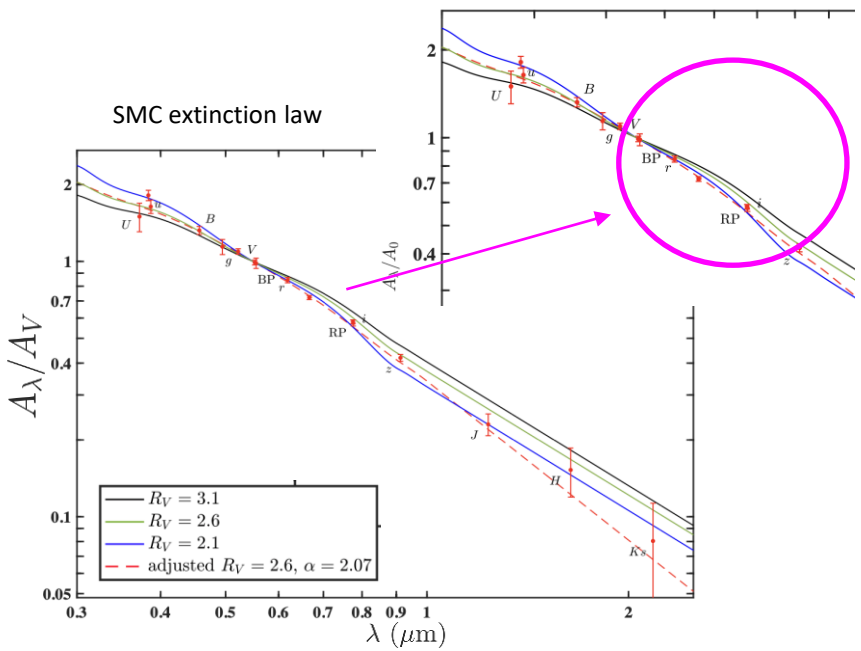


Wang & Chen 2019, ApJ

大、小麦哲伦云星系消光规律

更准确！

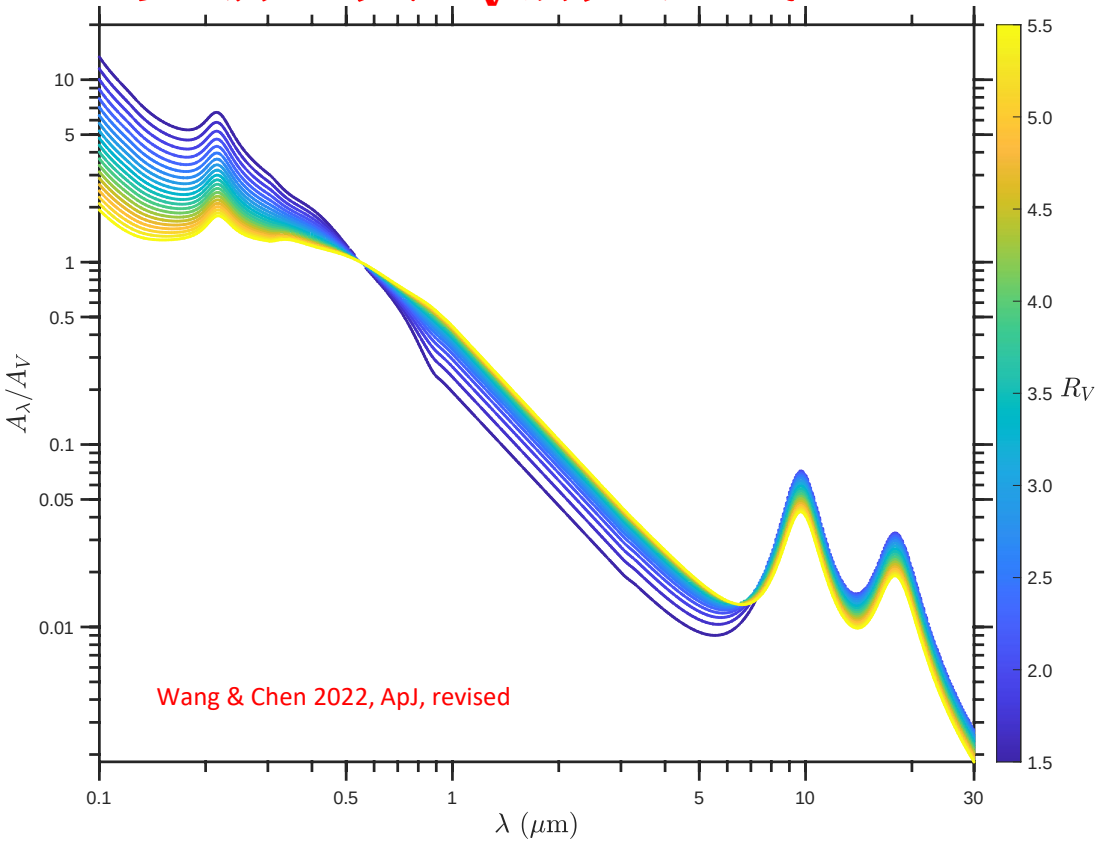


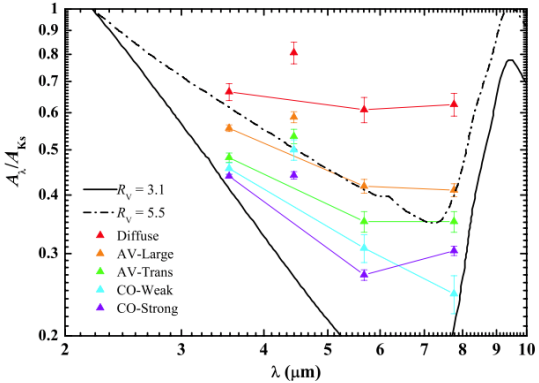


Wang & Chen 2022, ApJ, revised

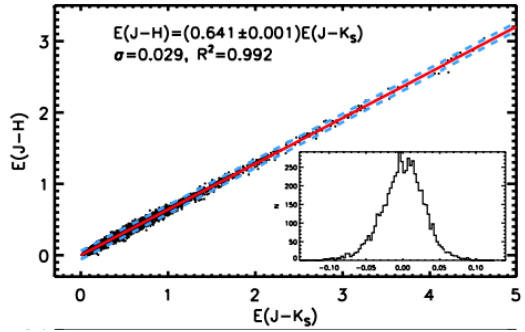
- Adjusted coefficients in CCM $R_V = 3.4$ (LMC) & 2.6 (SMC)
- New extinction curve (dash line): better than 3%

更新经典R_V消光曲线



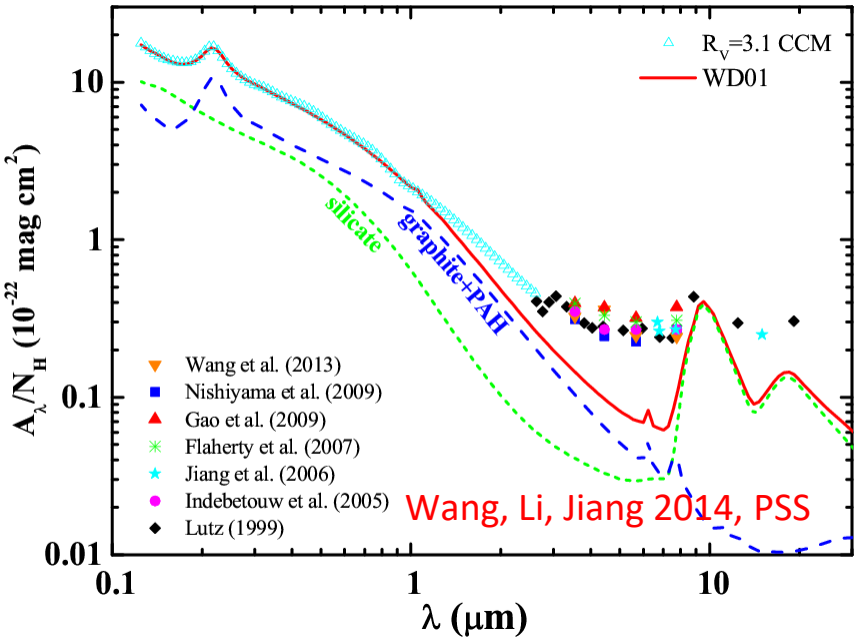


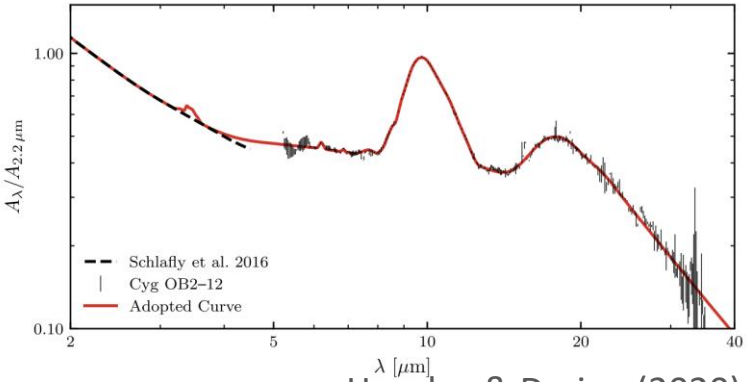
Wang +2013, ApJ



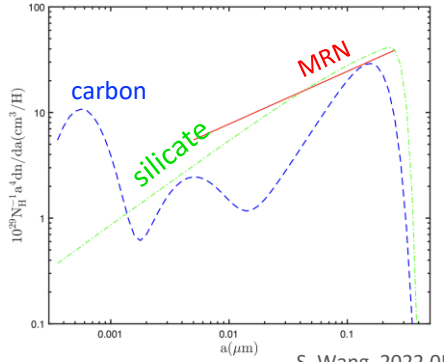
Wang & Jiang 2014, ApJL

星际尘埃





Hensley & Draine (2020)



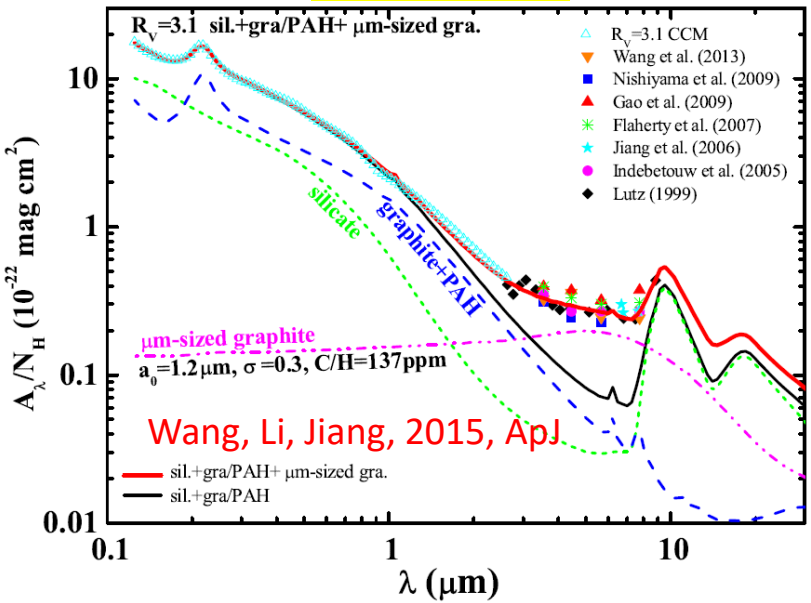
S. Wang, 2022.05.21

➢ 平坦的中红外消光无处不在！

星际尘埃：甚大尘埃

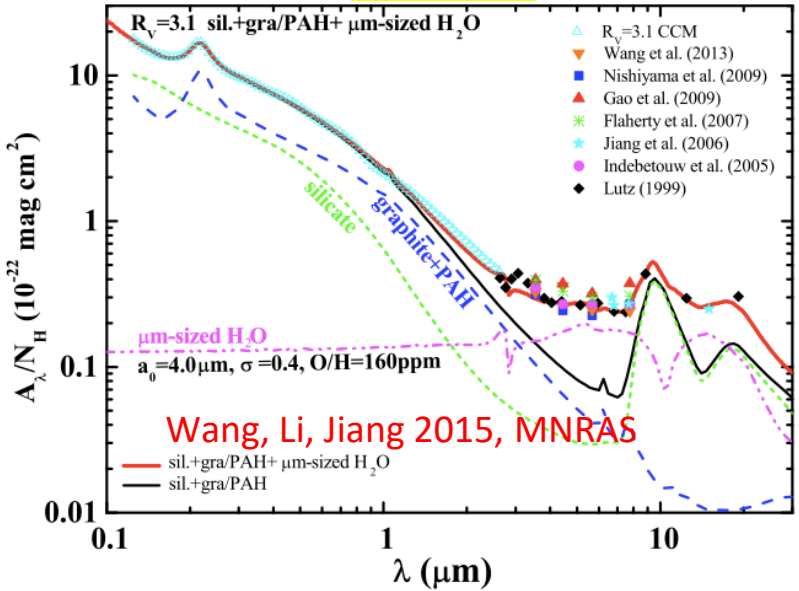
- 微米尺寸, 0.5 μm <a < 5 μm， WLJ尘埃 模型

graphite石墨



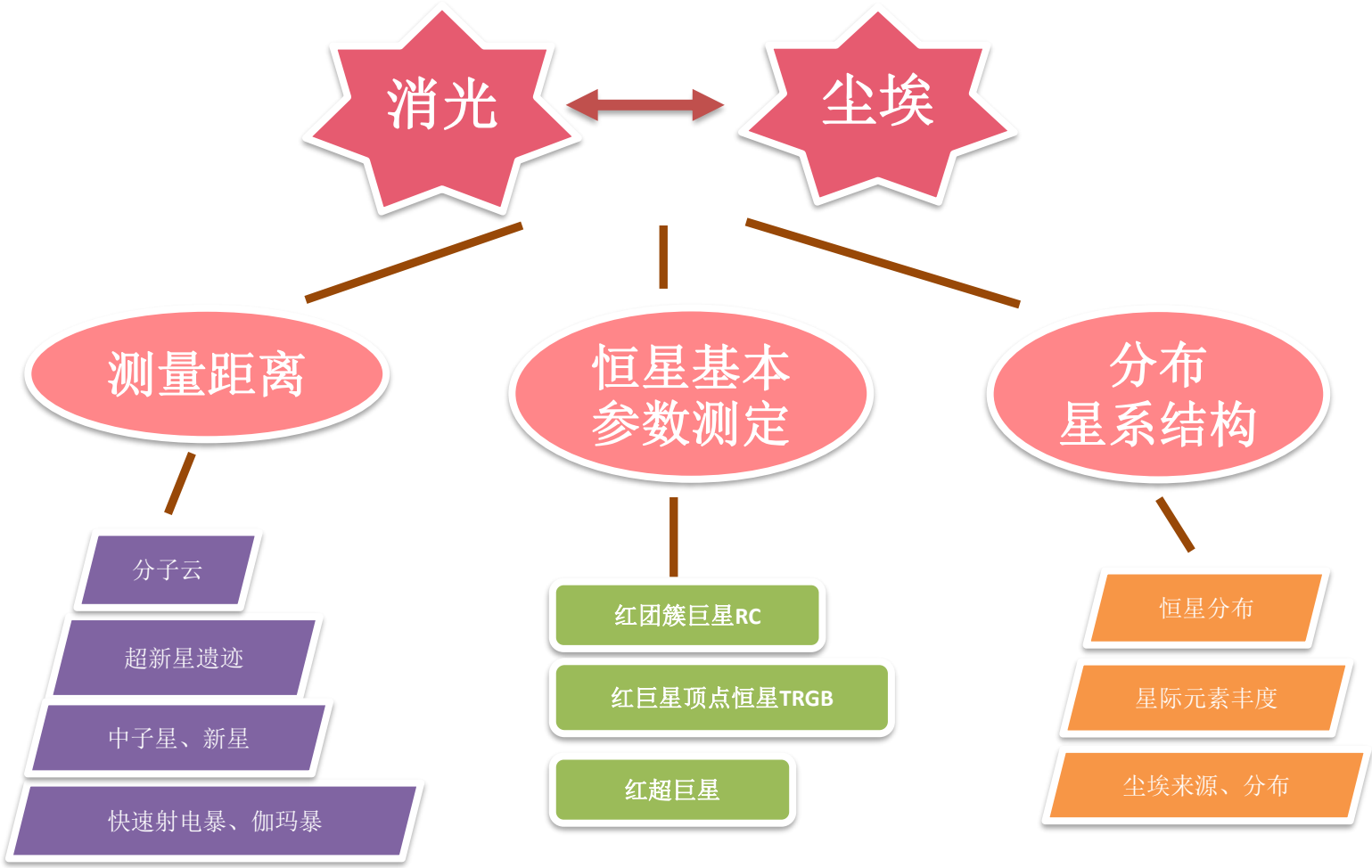
Wang, Li, Jiang, 2015, ApJ

H_2O 水冰



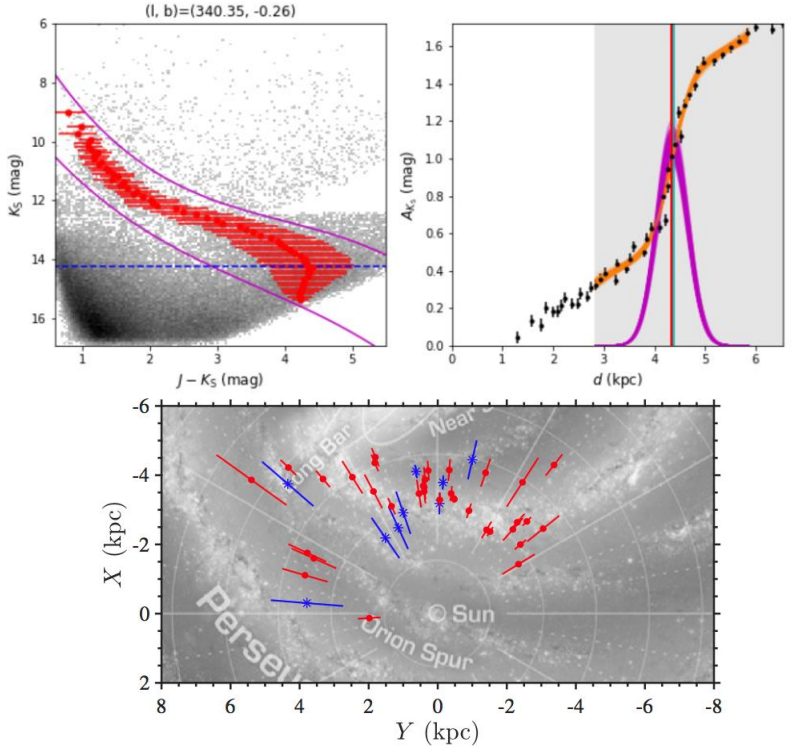
Wang, Li, Jiang 2015, MNRAS

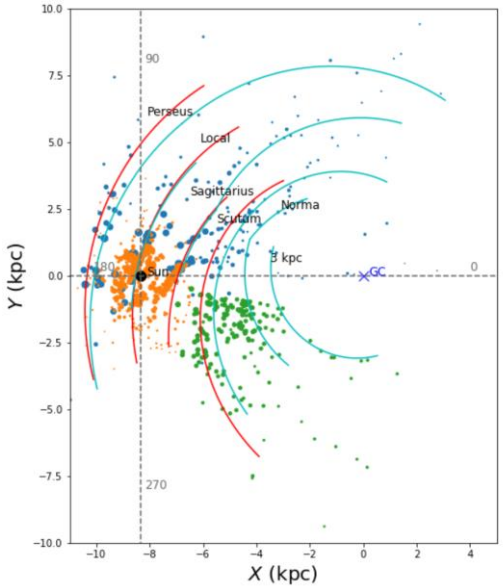
- 星际O问题”Oxygen Crisis”


消光
尘埃
测量距离
恒星基本
参数测定
分布
星系结构
分子云
超新星遗迹
中子星、新星
快速射电暴、伽玛暴
红团簇巨星RC
红巨星顶点恒星TRGB
红超巨星
恒星分布
星际元素丰度
尘埃来源、分布

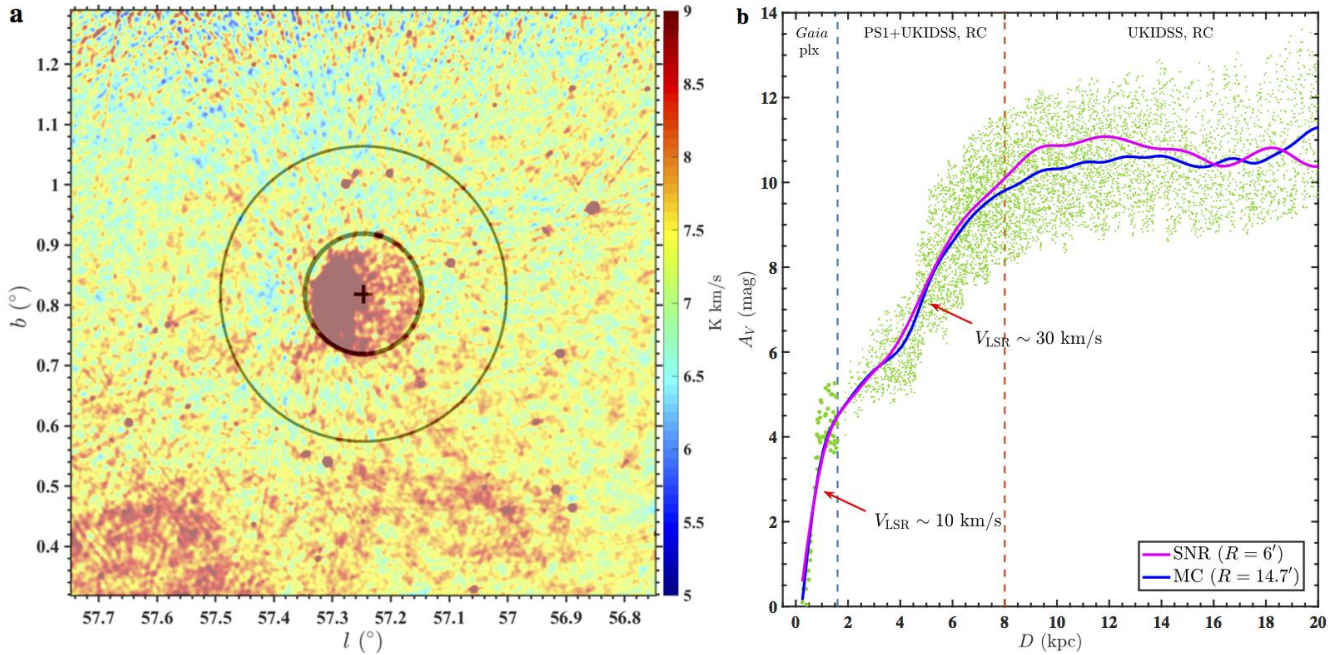
应用1----消光测距

- 利用红团簇巨星消光随距离的变化测量天体距离



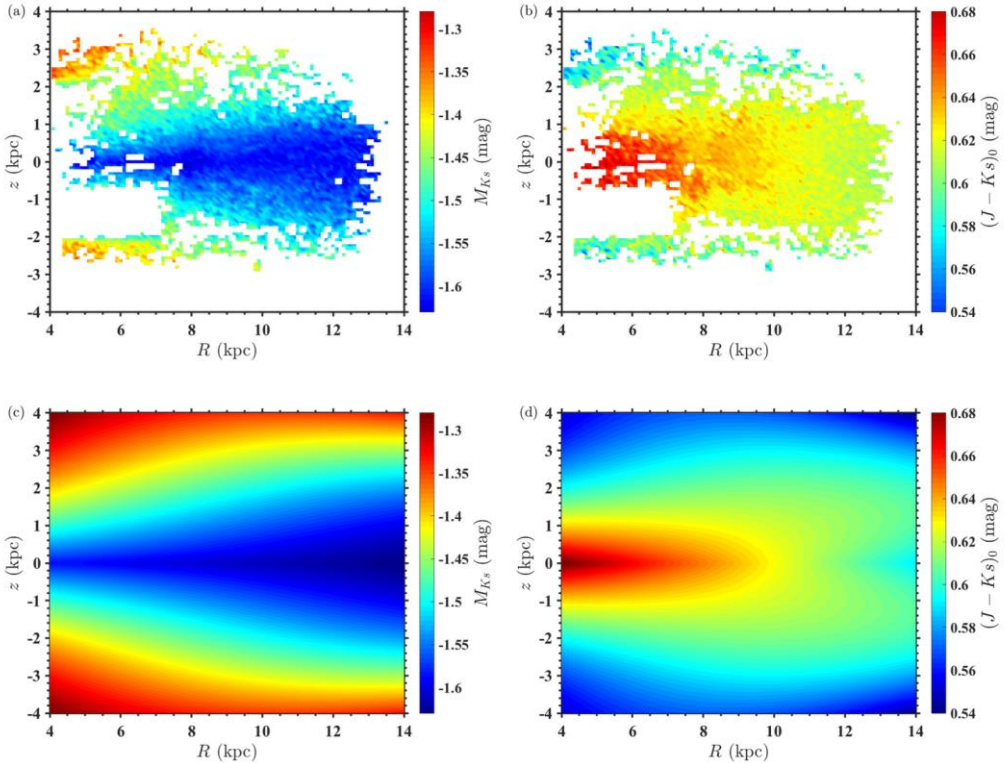


- 63个超新星遗迹，Wang et al. 2020, A&A
- 169个分子云，Chen, Wang et al. 2020

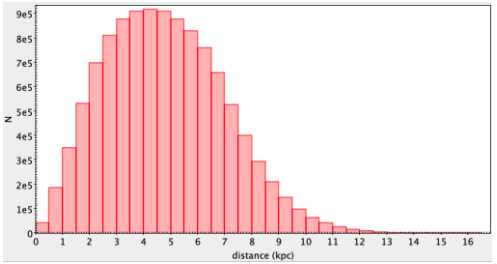


- 结合射电观测，测定快速射电暴距离
  - **FRB 200428**

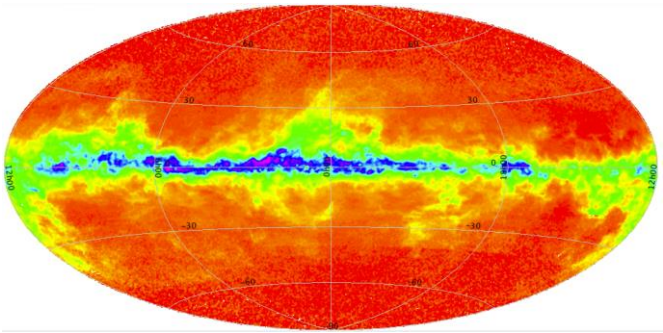
应用2----恒星性质：红团簇巨星三维参数图



全天样本



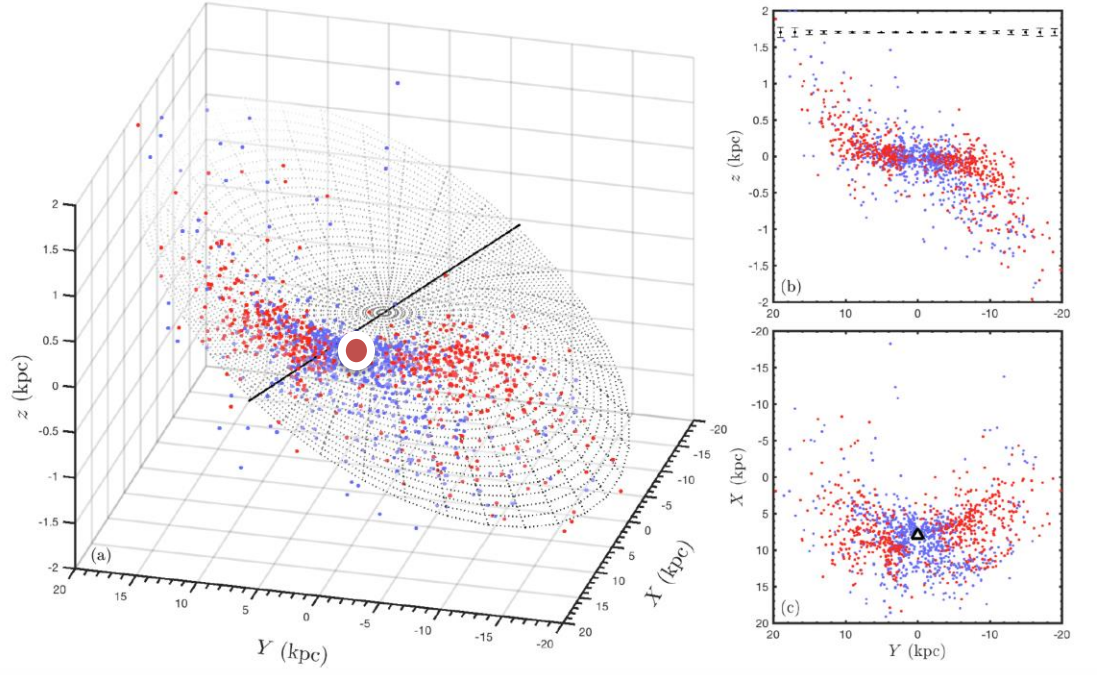
消光图



Wang & Chen, 2021, ApJ

应用3----精确距离、银河系结构

- 首次发现证实银河系存在弯曲的恒星盘

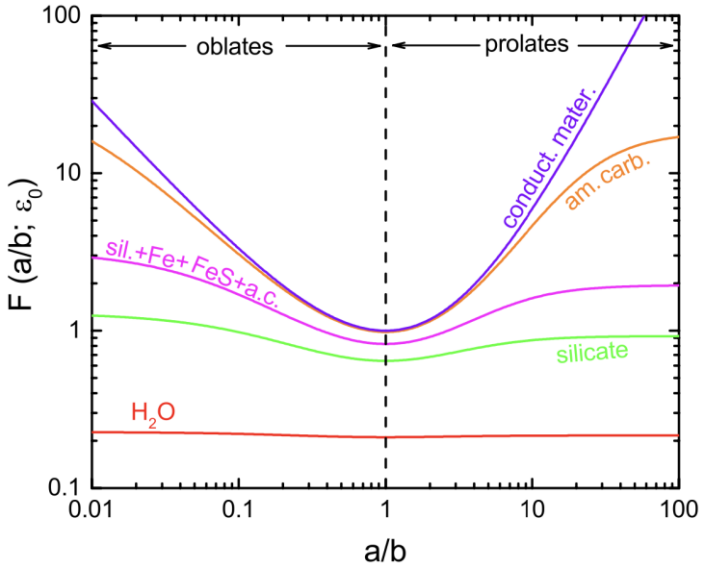


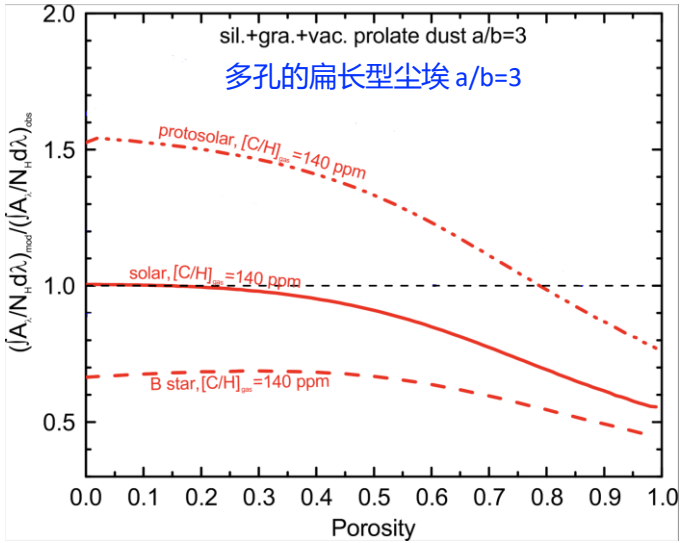
Chen, Wang et al., 2019, Nature Astronomy

应用4----限制星际元素丰度

- Kramers-Kronig 关系: 限制ISM 中的尘埃量 (Purcell 1969)

$$\int_0^\infty \frac{A_\lambda}{N_{\rm H}} d\lambda = 1.086 \times 3\pi^2 \frac{V_{\rm dust}}{\rm H} F\left(\epsilon_0; \text{shape}\right)$$





B 型星丰度: 太低！

Wang, Li, Jiang, 2022. in preparation

星际消光、尘埃及深度应用

- 星际消光
  - 紫外（CSST）、红外消光（JWST）与环境
  - 星系消光
- 星际尘埃
  - 性质、来源、分布
- 深度应用----创新性工作
  - 恒星物理 ➔ 示踪天体性质
  - 提高示踪天体距离精度➔ 星系研究结构
    ➔ TRGB &哈勃常数
  - 消光测距 ➔ 有消光的天体 & 全天消光随距离分布

谢谢各位老师和同学!