Measuring Open Clusters with Photometric Survey Data

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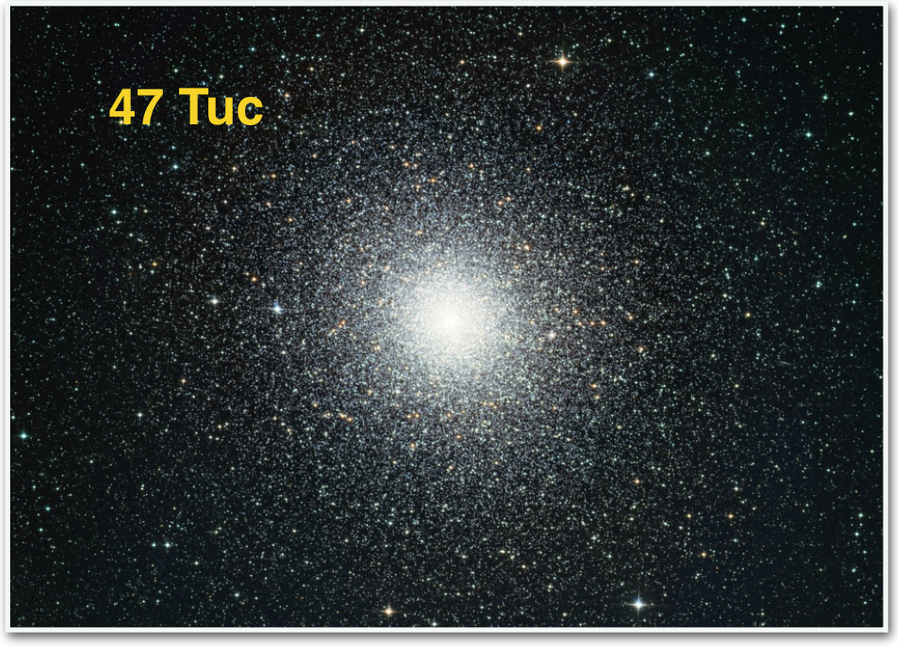
Background

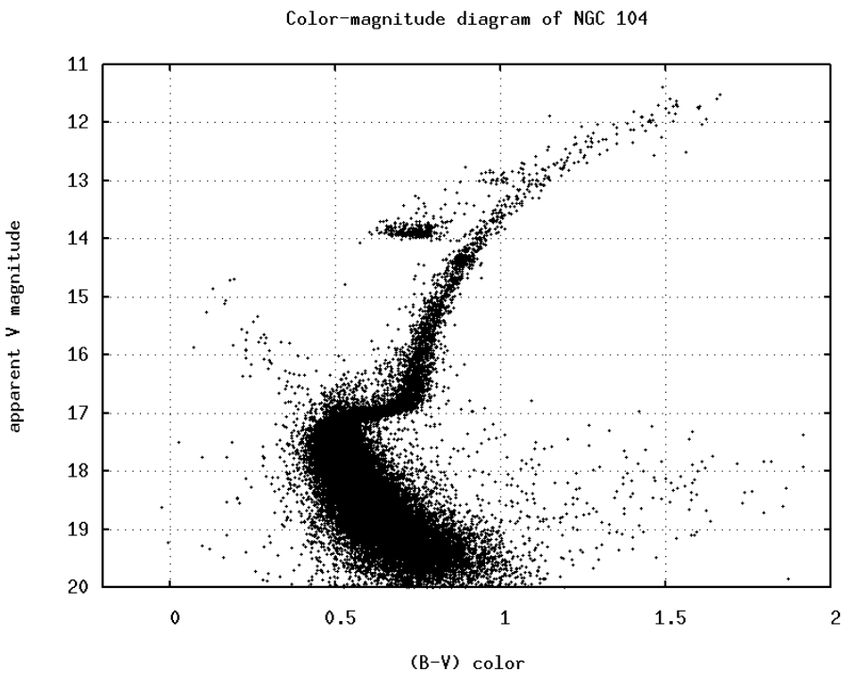
分子云团中诞生恒星 ➔银河系中演化、运动与瓦解 ➔ 场星+现存的团

- 保留了团形成时的许多重要信息：年龄、运动、金属丰度
- 准确的整体运动和平均物理特征，星团独有的年龄、距离测量
- 宽的年龄谱(My~Gy)：盘结构和恒星形成历史在演化各阶段的特征

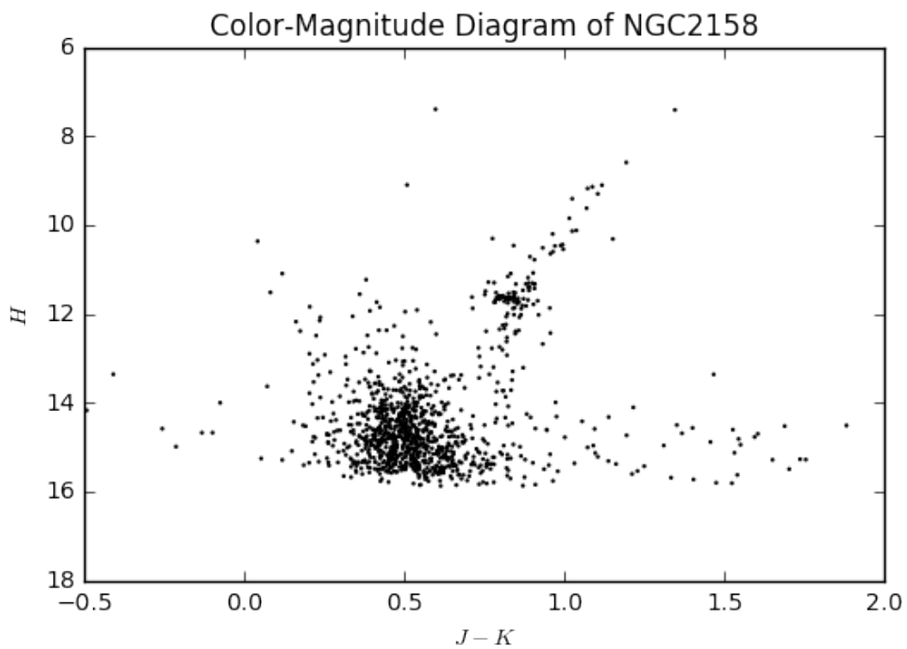
问题：场星污染严重！

Problem in measuring the OCs





Globular cluster



Open cluster

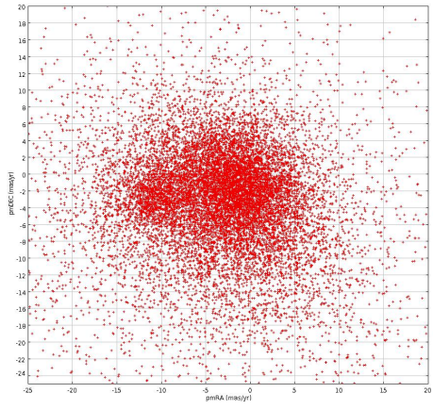
Usual method

成员 → 团参数

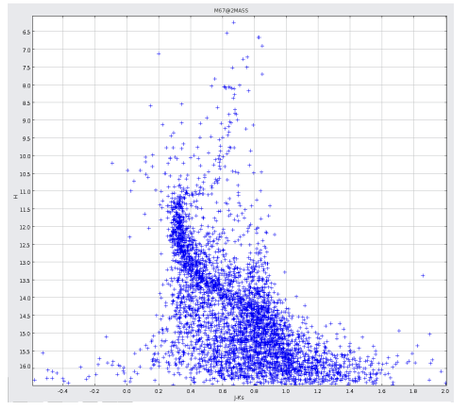
CMD上扣除场星 → 团参数

只适用于少数团!

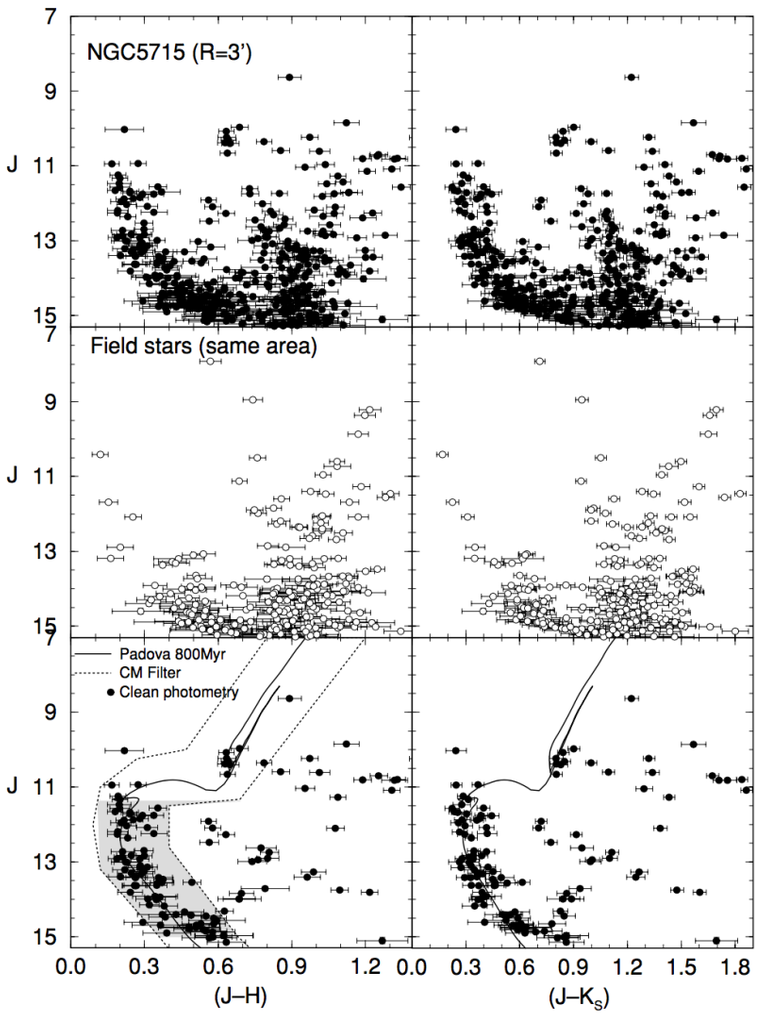
Coordination



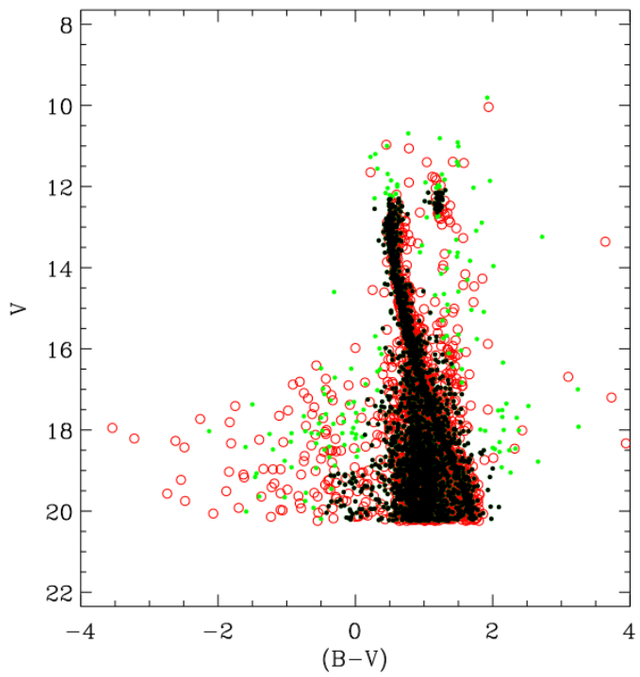
Proper motion

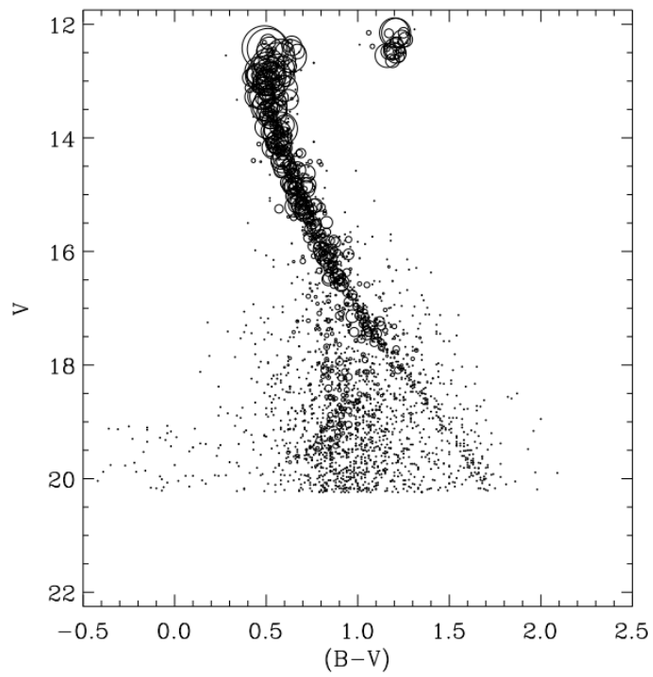


Color-magnitude



Bonatto, 2007



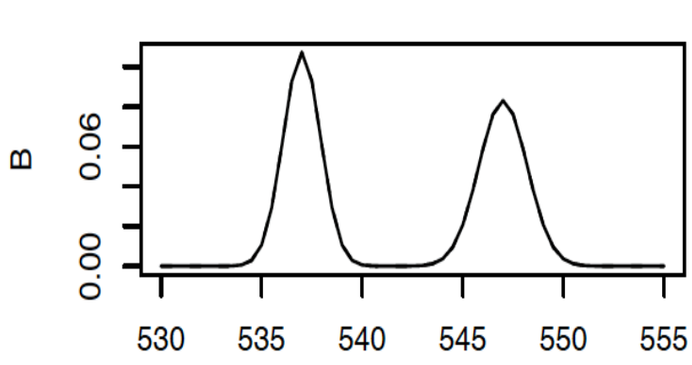


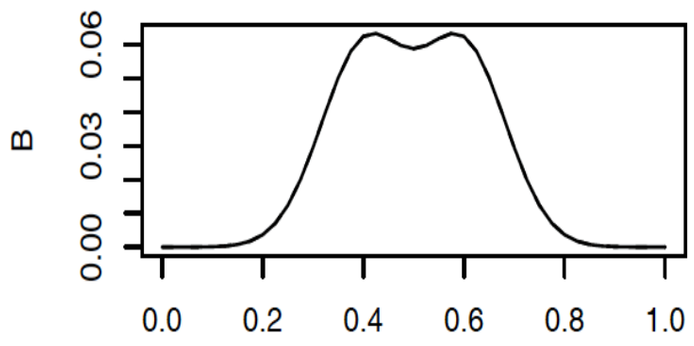
H. Monteiro , 2010

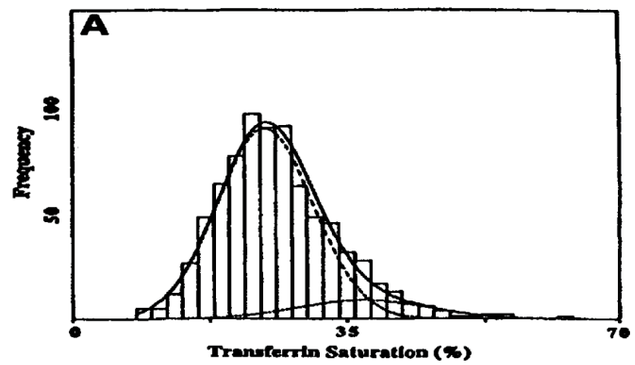
Mixture Model Method

混合模型：对星团的参数直接测量，适用于所有星团

两种成分的混合：





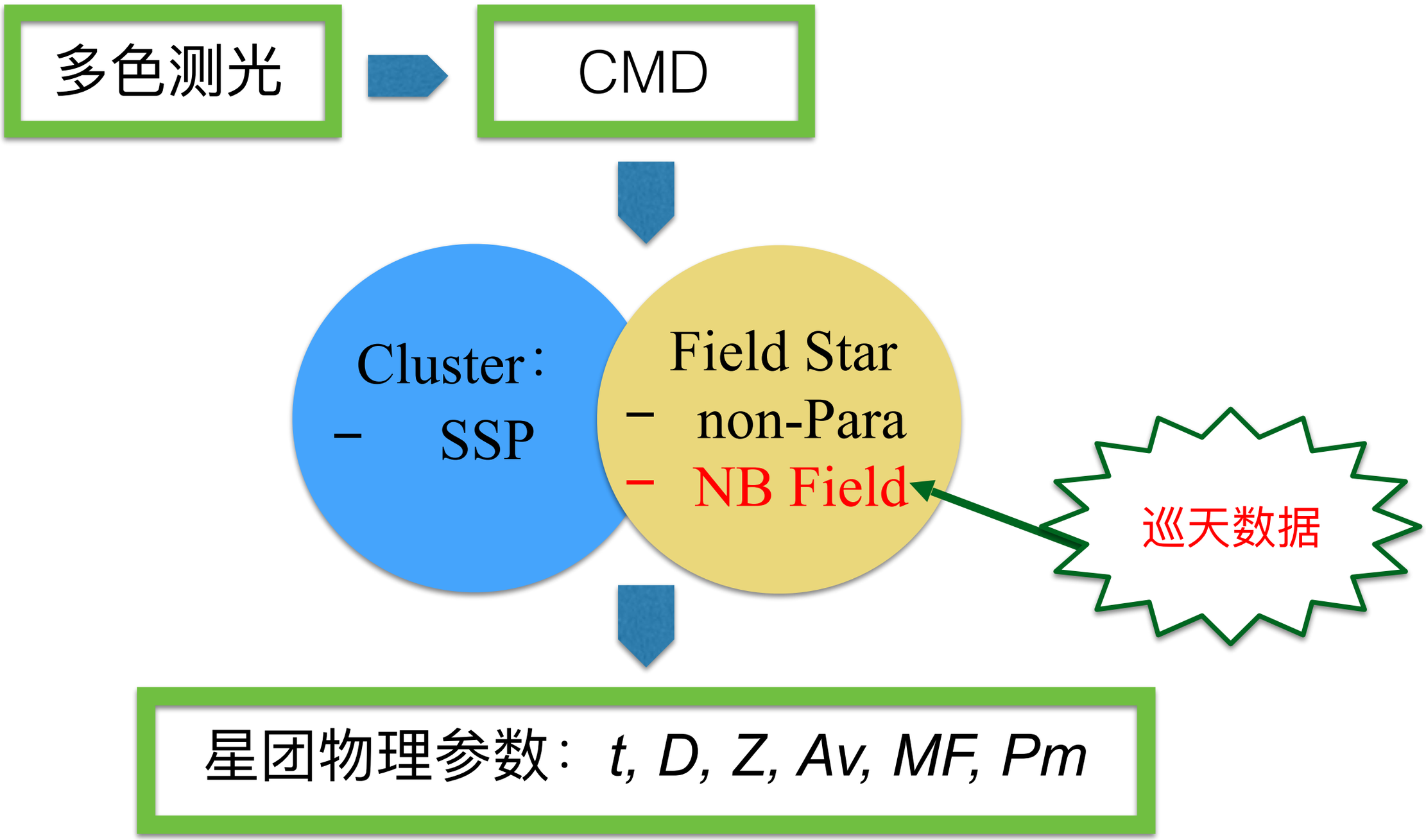


利用周围场星作为prior：基于贝叶斯推断的统计框架

$$\Phi(\Theta) = \Phi_C(\Theta_C) + \Phi_F(\Theta_F)$$

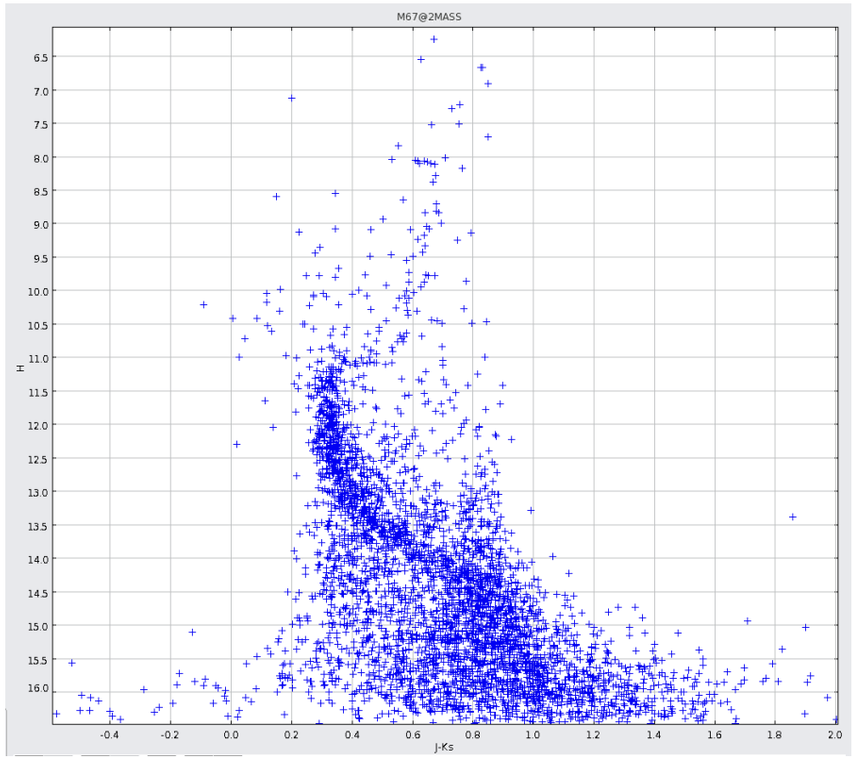
大数据巡天为其提供了可能！

Schematic of Mixture Model



Mixture Model of Photometric Data (CMD)

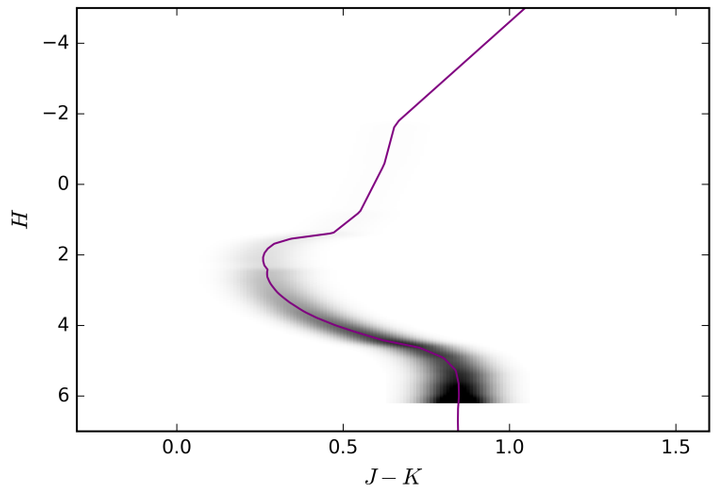
Cluster region:



Cluster members:

Isochrone of SSP $(\Theta_C = t,\ D,\ Z,\ Av,\ MF)$

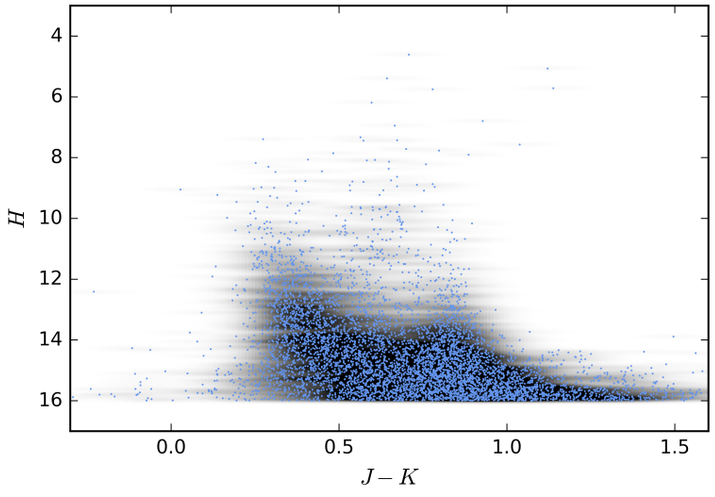
→ number density in CMD: $\Phi_C(C,M)$



Field stars:

Nearby field stars (isolate)

→ number density in CMD: $\Phi_F(C,M)$



For each star:

$$L_i = \Phi(C_i, M_i \mid \Theta) = \Phi_C(C_i, M_i \mid \Theta_C) + \Phi_F(C_i, M_i)$$

$$\ln L = \sum_i \ln L_i$$

$$L(t, D.....) \Rightarrow L_{\max}$$

Result — Mock test

N_cl = 500

N_fs = 1000

bands = J, H, K

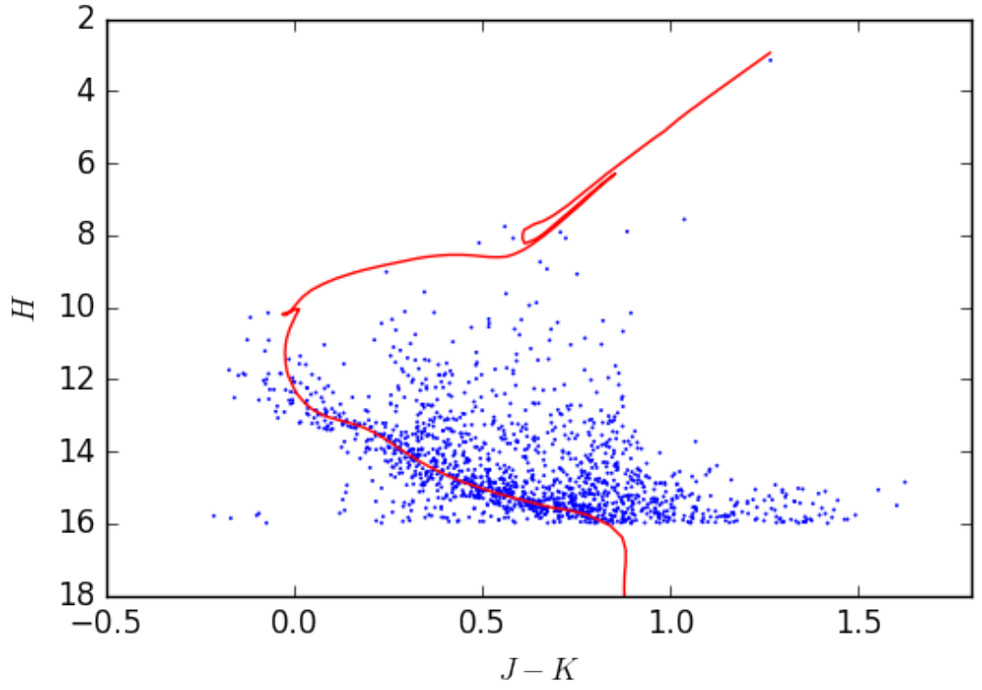
errors = 0.05

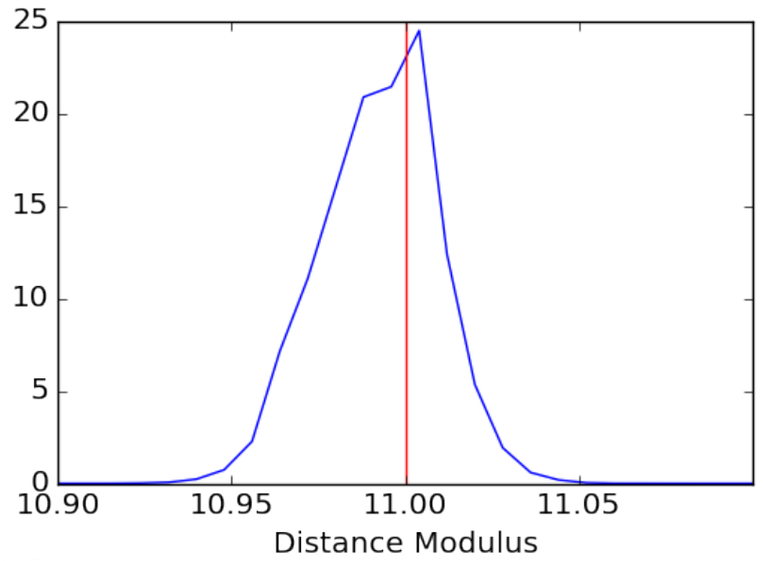
D_M = 11

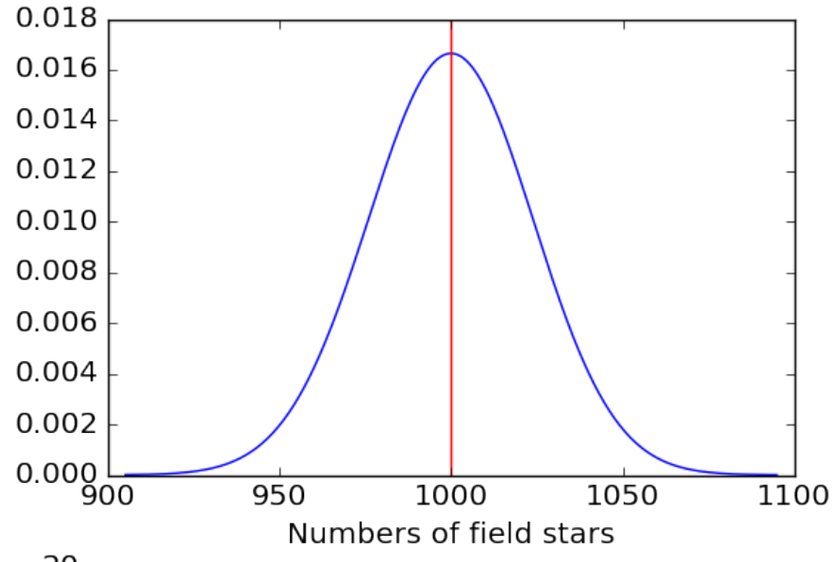
lg t = 8.5

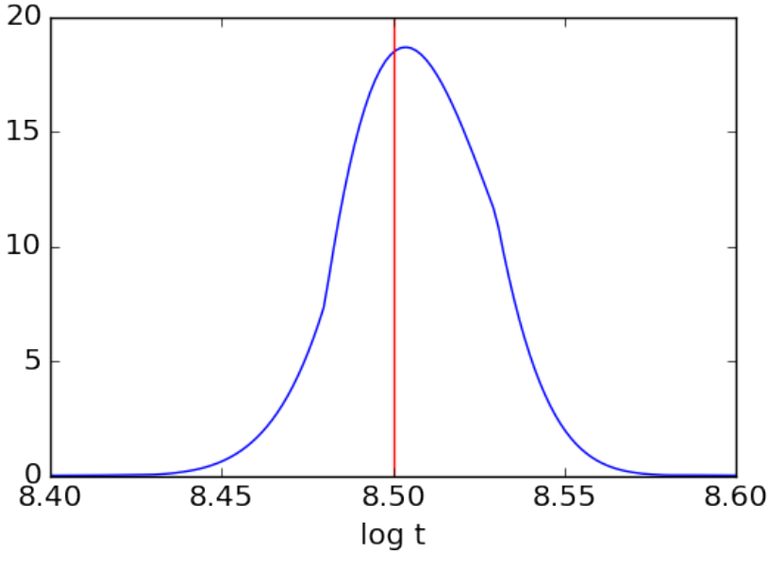
[Fe/H] = 0.04

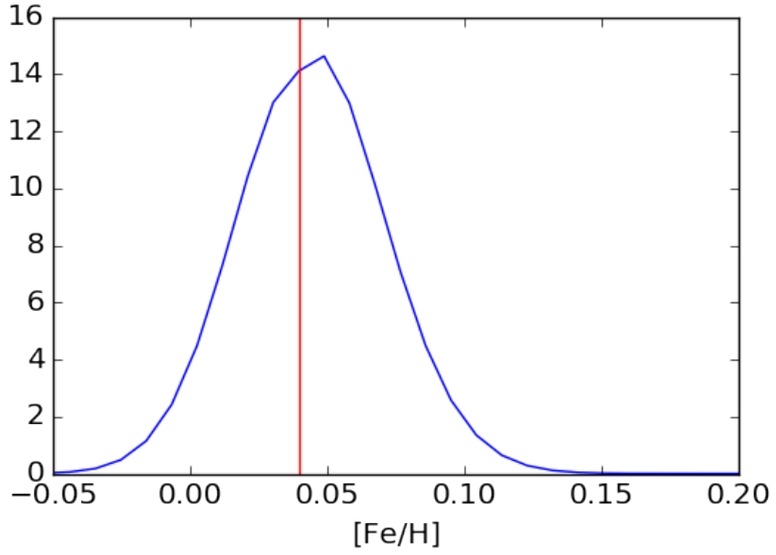
Av = 0.2

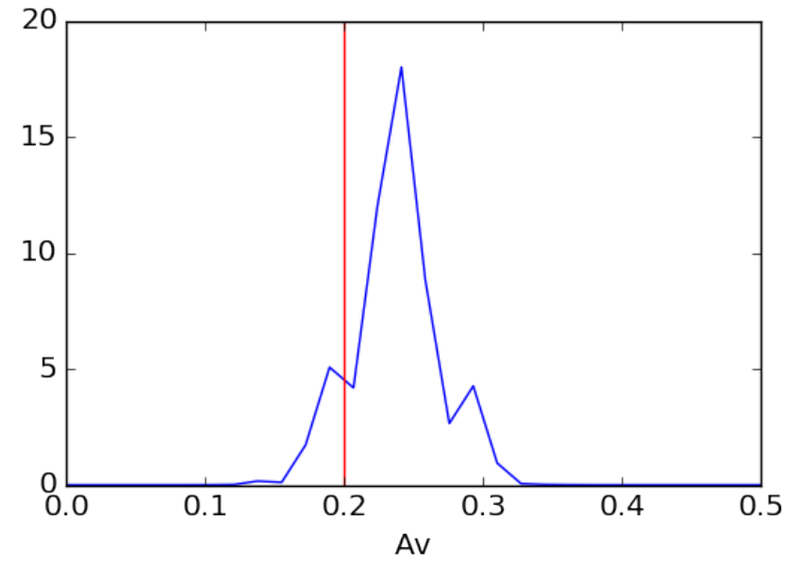












Result — Mock test

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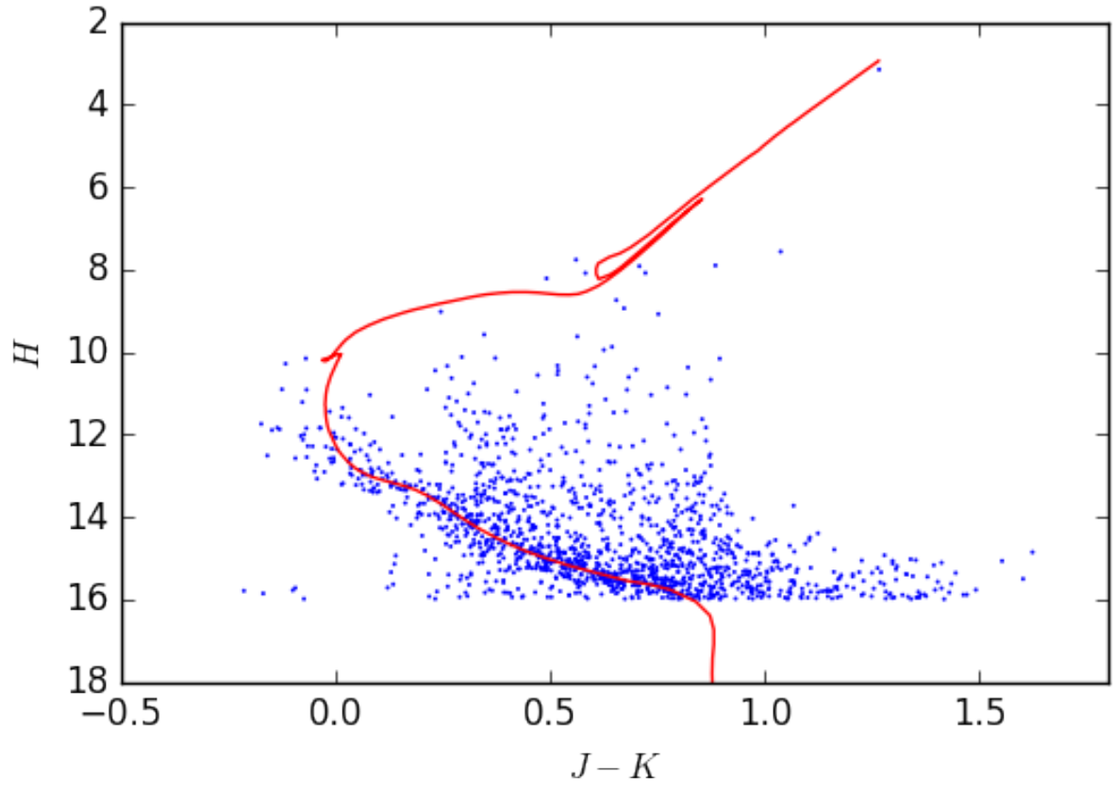
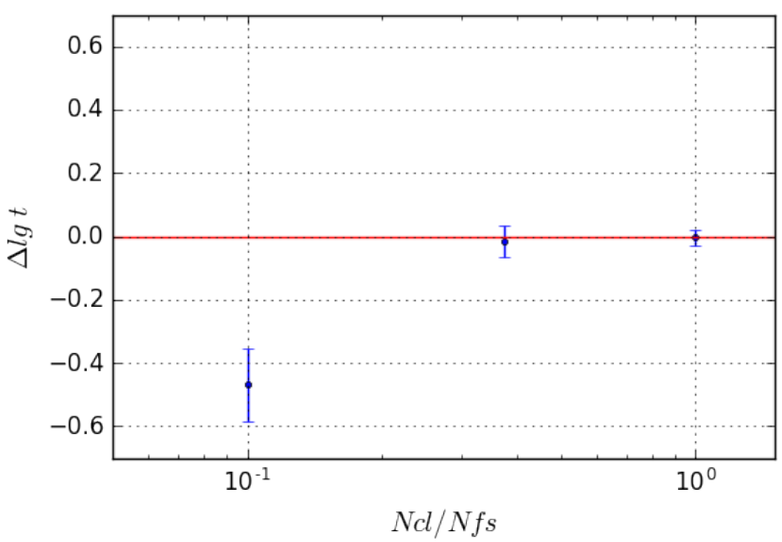


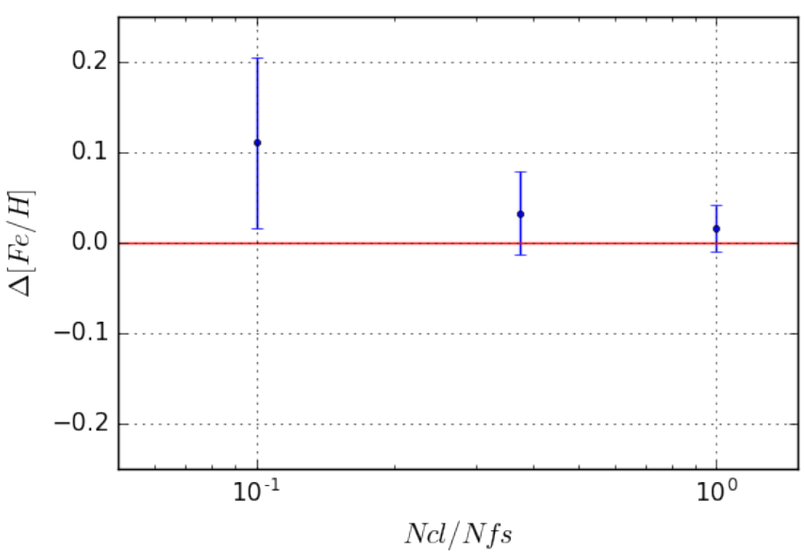
100次拟合结果 **我们的结果** **Perren ,2015**

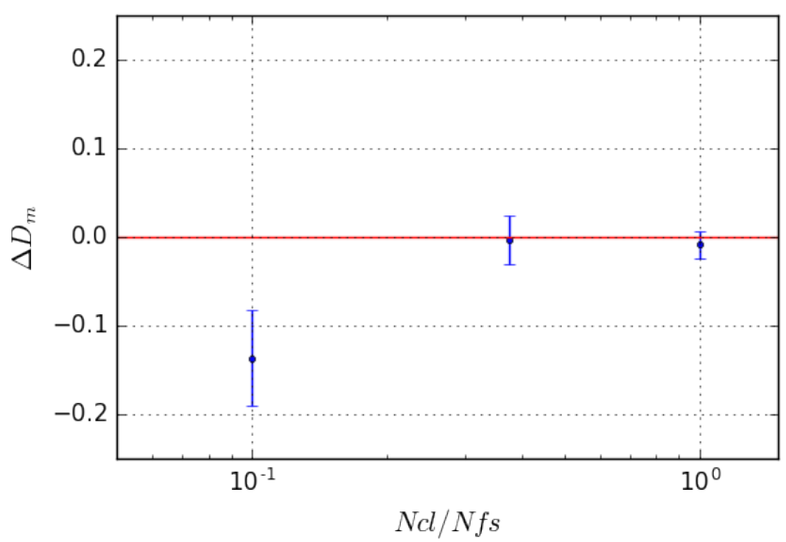
Parameters	<Δ>	<err>	<Δ>	<err>
log t	-0.01	0.03	0.40	0.70
[Fe/H]	0.04	0.03	-0.10	0.14
D_m (mag)	-0.01	0.02	<0.05	<0.05
Av (mag)	0.04	0.03	0.20	0.10
N_fs	0.72%	2.38%	-	-

Result — Mock test

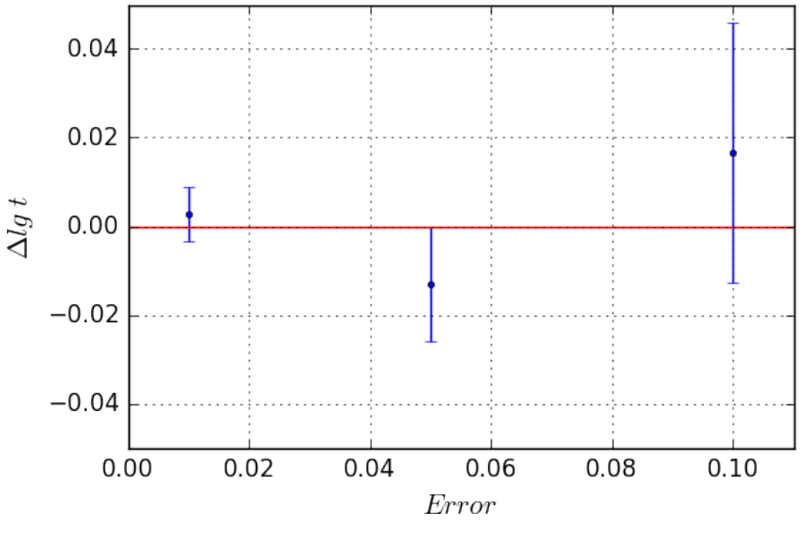
<err>及<Δ>随场星混合程度减小而减小：(总星数=1100)

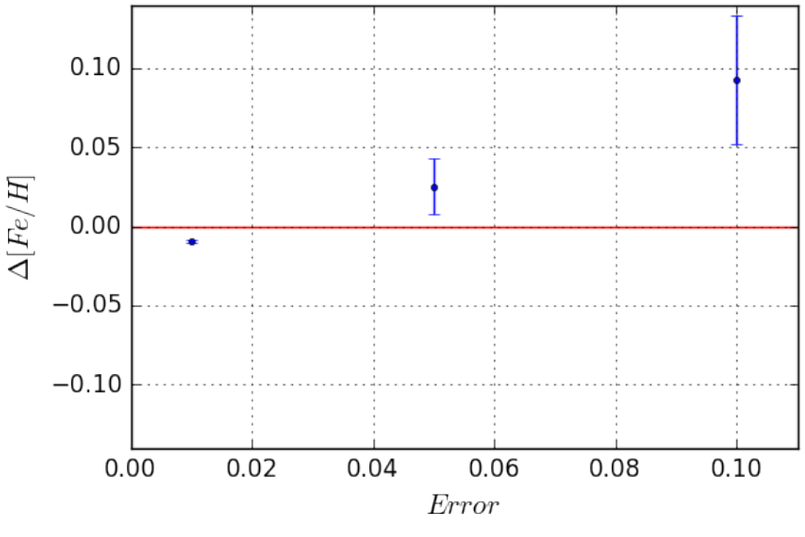


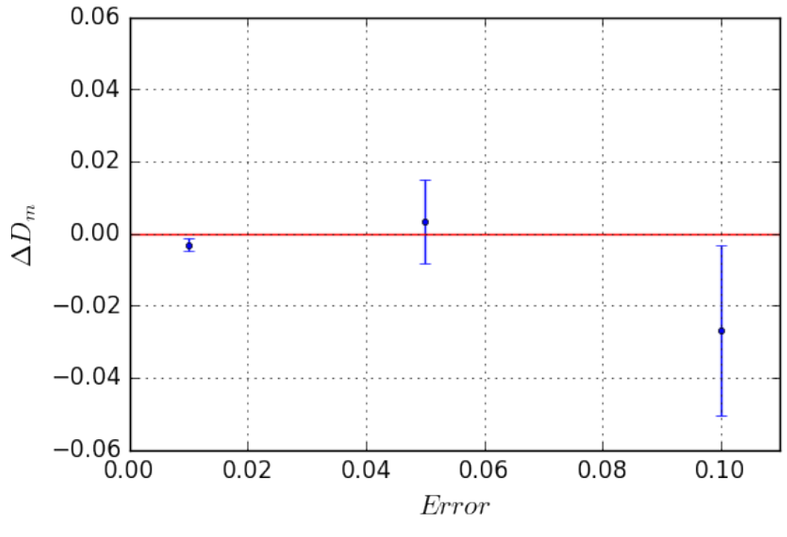




<err>及<Δ>随星团测光误差的增大而增大：



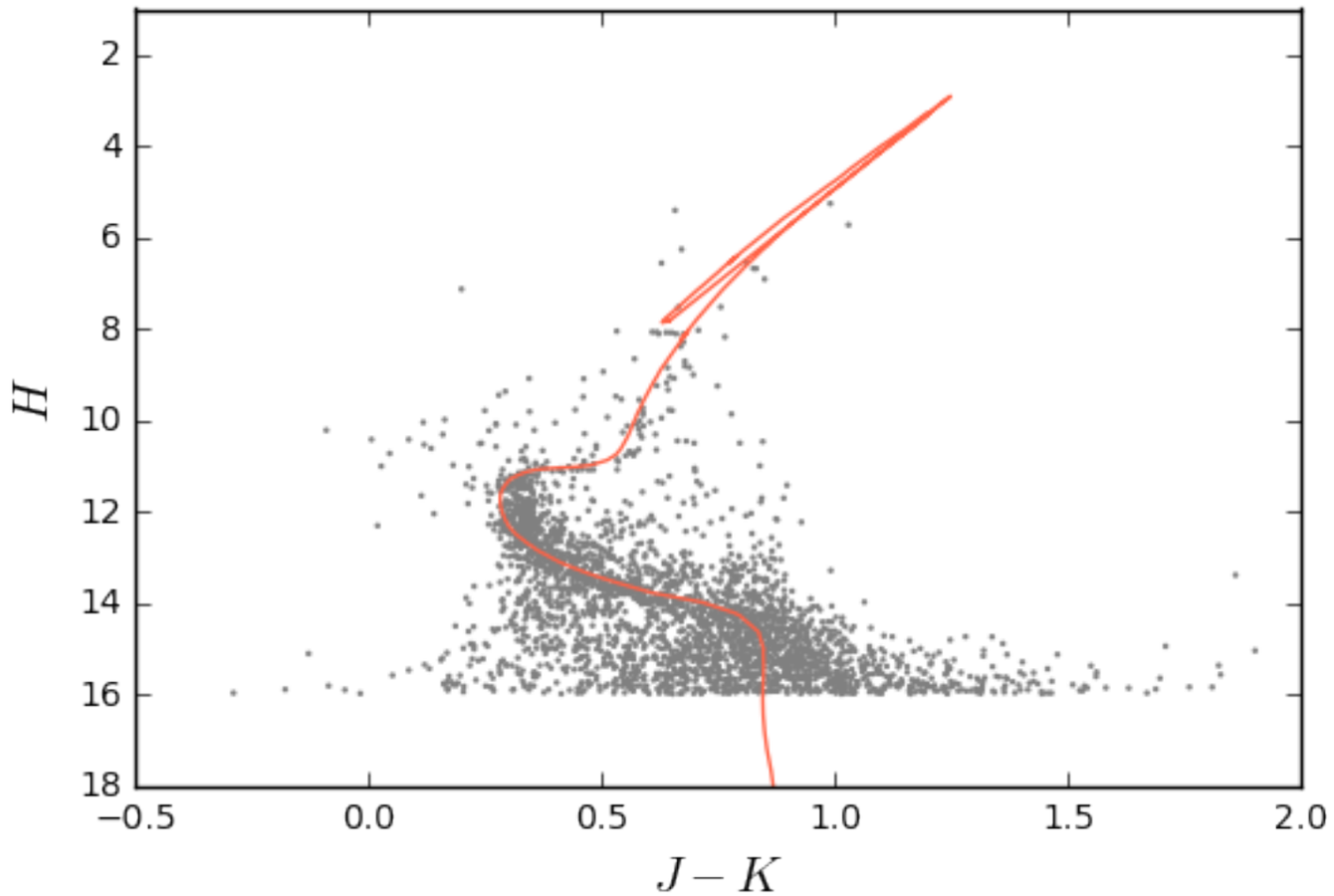


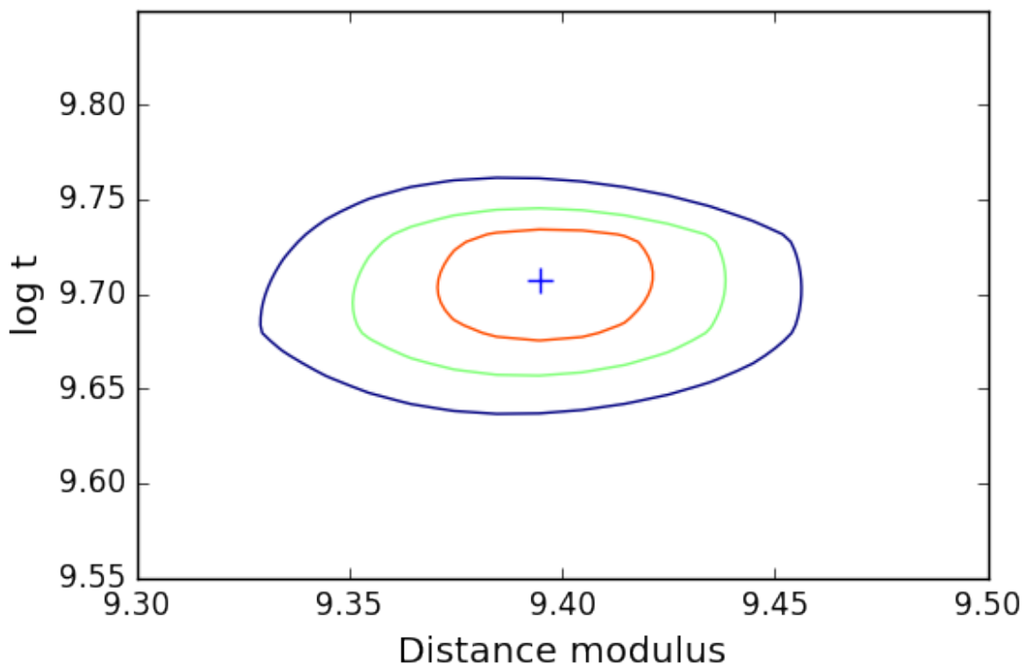


Result — M67 @ 2MASS (J,H,Ks)

$R < 30\ arcm, \quad H < 16.0 \quad \sim 3000$ stars

$Field \sim 4\ \mathrm{deg}^2$





$D_{\mathrm{M}} = 9.39 \pm 0.02, \quad \lg t = 9.71 \pm 0.02$

Result — Membership

N_cl = 500

N_fs = 1000

bands = J, H, K

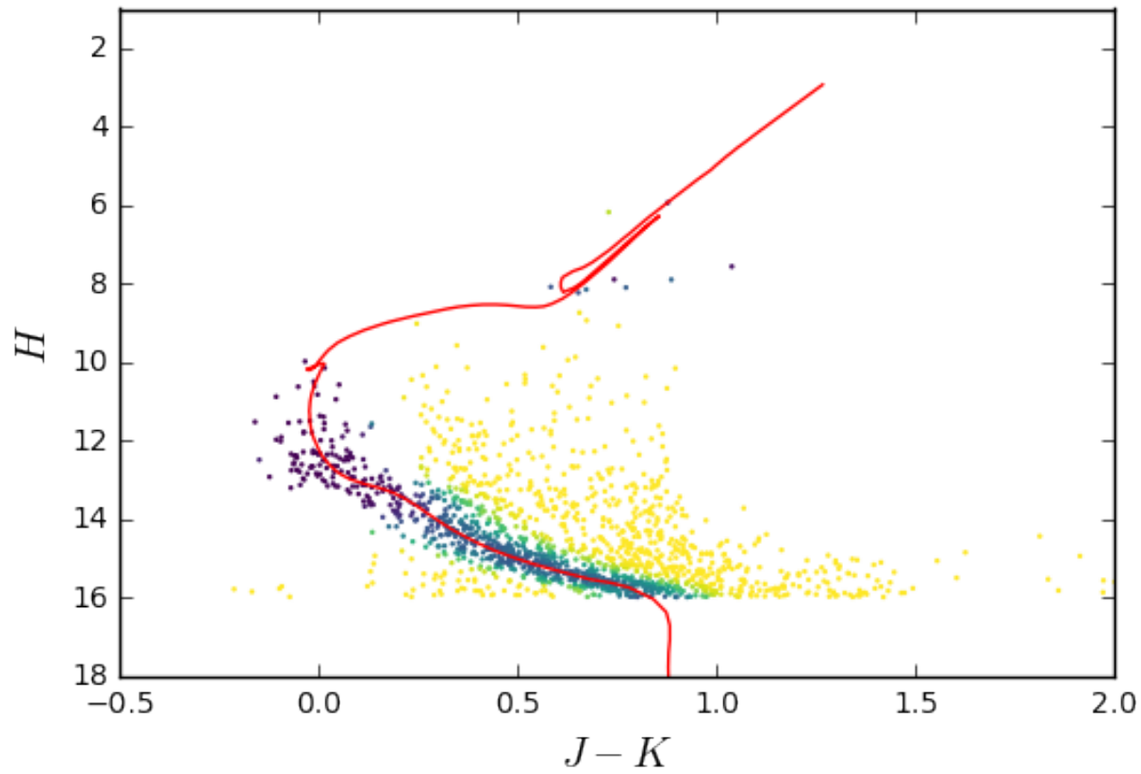
errors = 0.05

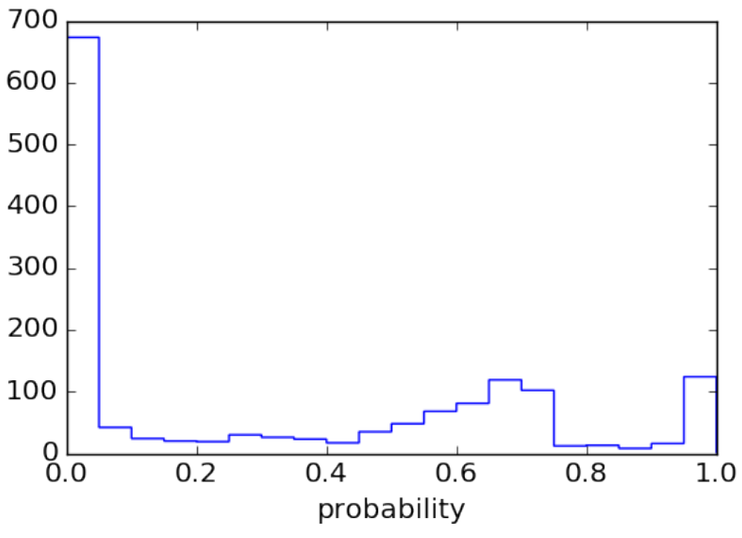
D_M = 11

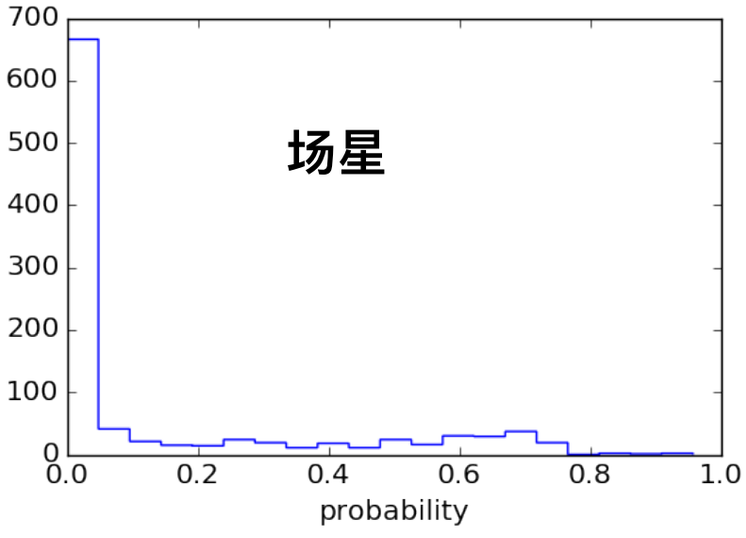
lg t = 8.5

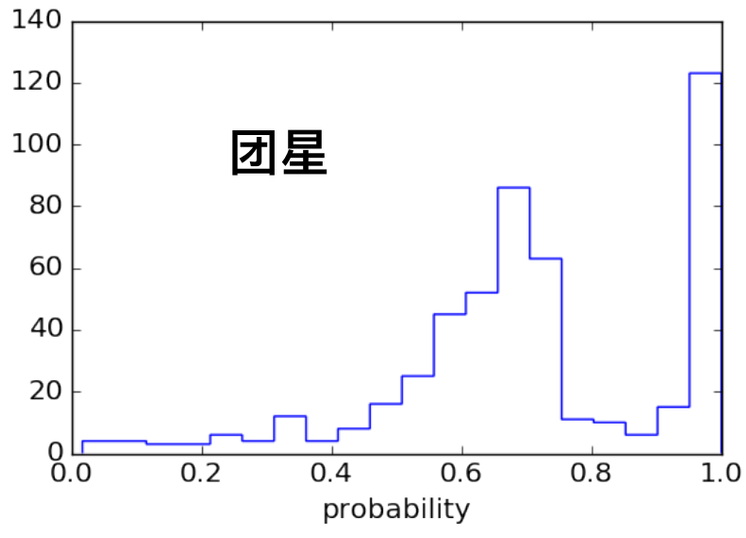
[Fe/H] = 0.04

Av = 0.2

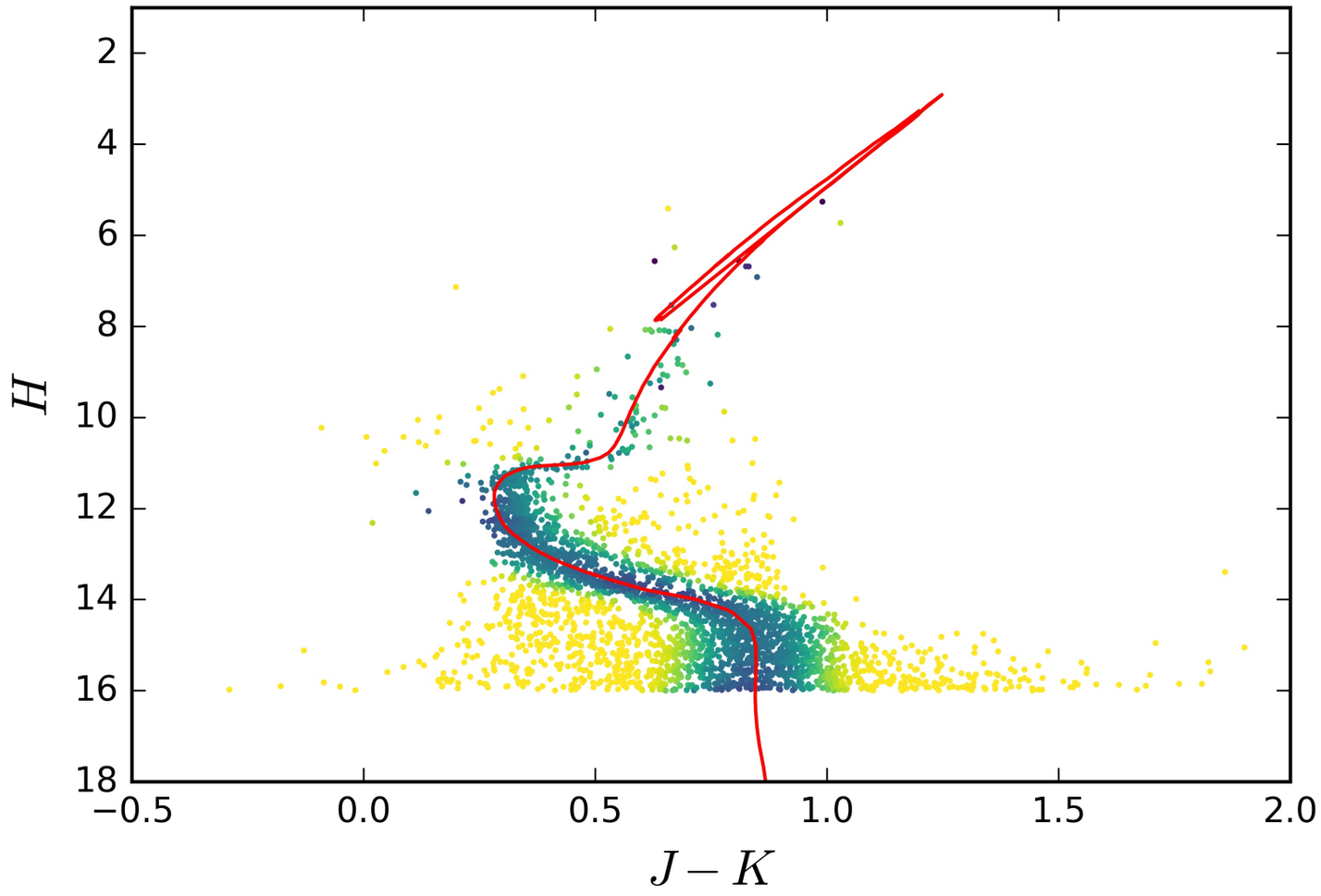


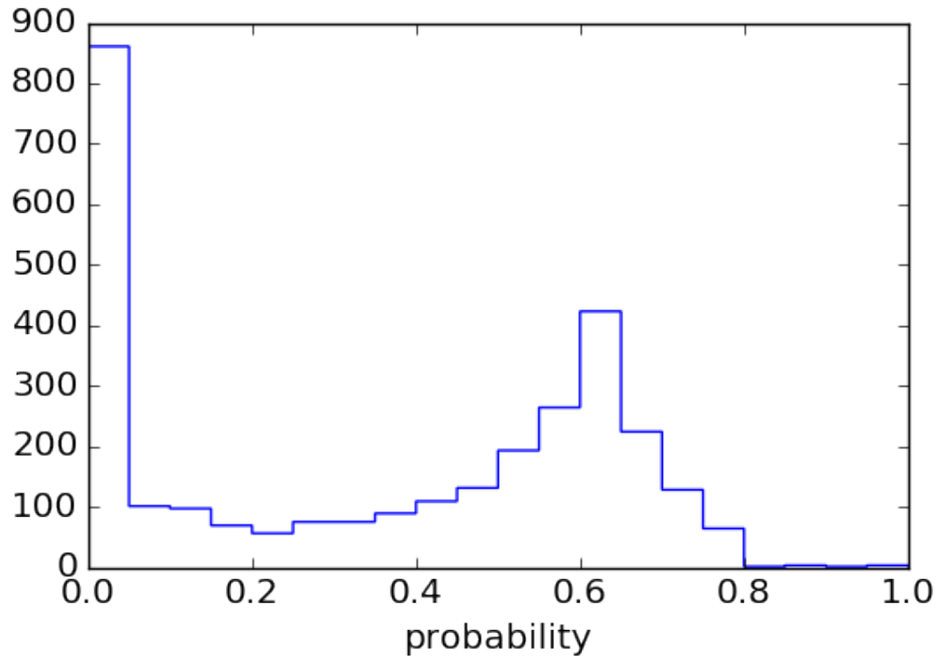






Result — Membership （M67）





To be continued...

- 通过测光数据建立混合模型（单星族加场星）来拟合星团参数，如年龄、距离、金属丰度等;
- 也可以直接探测星团的质量函数、研究星团的双星比例等;
- 混合模型的方法还可以得到每颗星的成员概率。

- 通过和运动学成员的比较，我们可以研究一些异常的星，比如蓝离散星、双星等;
- 利用巡天数据，可以用该方法构建较完备的疏散星团样本;
- 我们的样本将包含LAMOST观测到的疏散星团;
- LAMOST给出的金属丰度信息可以作为我们参数估计的prior。

Thank you !