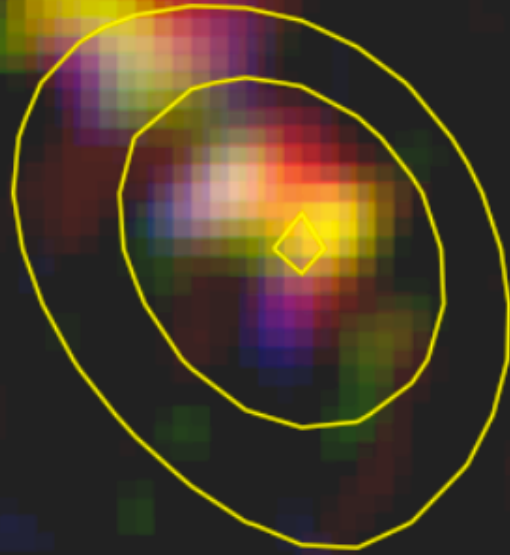


Dust production and galaxy evolution  
star-by-star  
JWST Early Science on Triangulum

Jacco van Loon

Keele University

dusty galaxy at  $z=7.5$

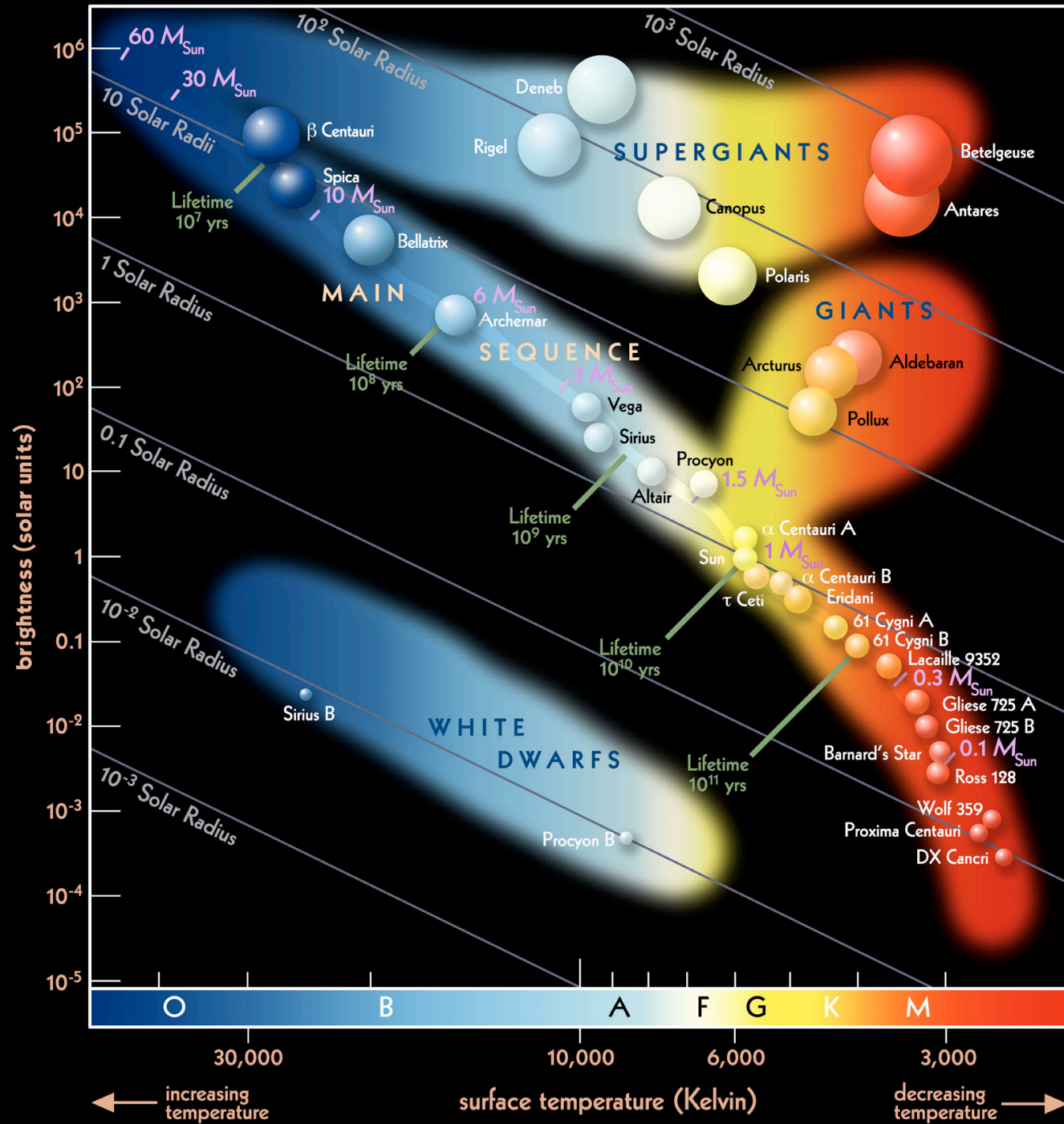


what's going on?

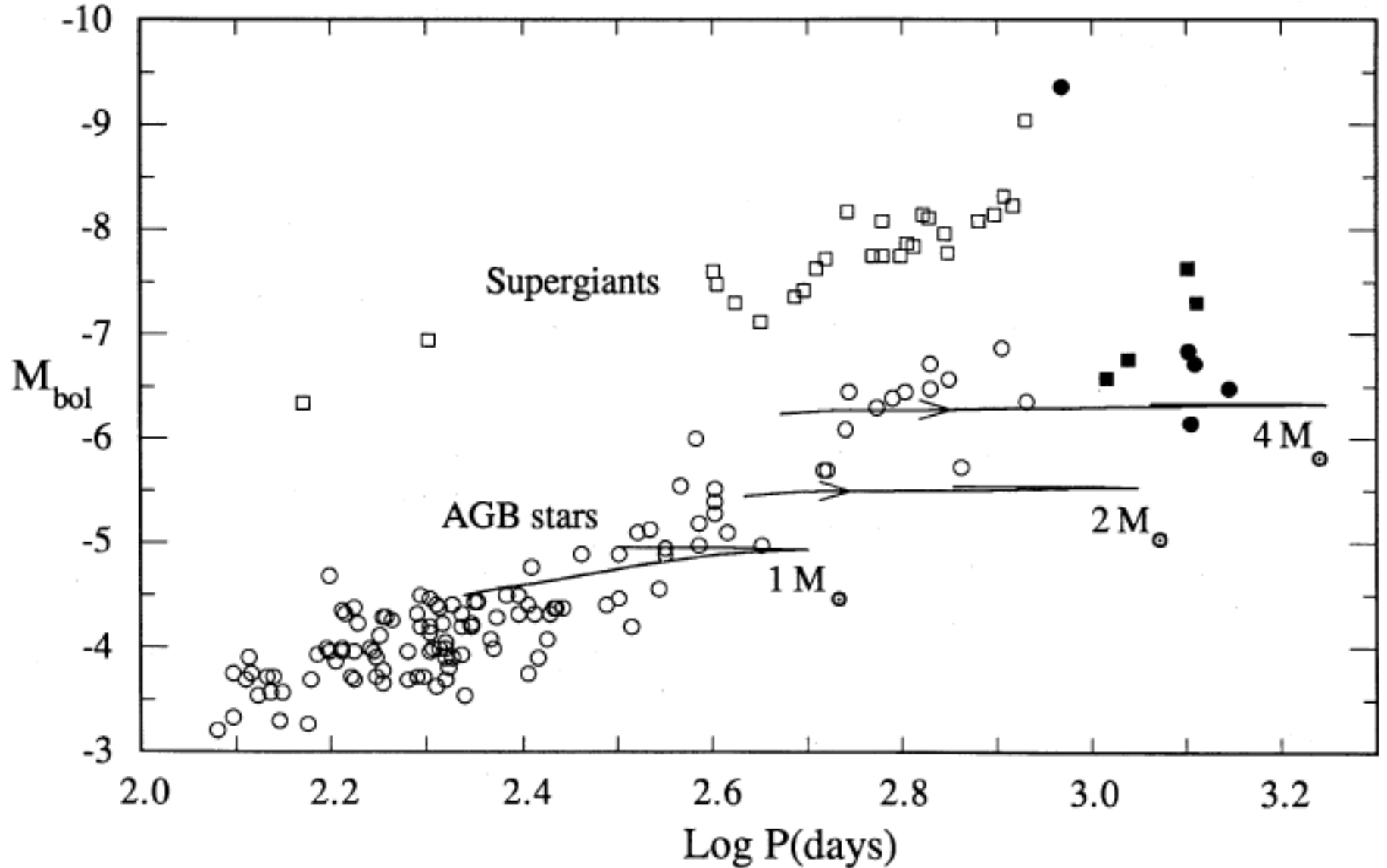
what happened since?

stars !





# long period variables (LPVs)



# star formation rate

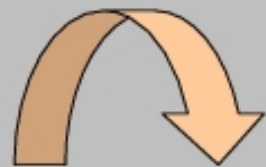
number of LPVs in time bin  $\delta t$

$$\xi(t) = \frac{dn'(t)}{\delta t} \frac{\int_{\min}^{\max} f_{\text{IMF}}(m) m \, dm}{\int_{m(t)}^{m(t+\delta t)} f_{\text{IMF}}(m) \, dm}$$

duration of LPV phase

# Dust formation

pulsation

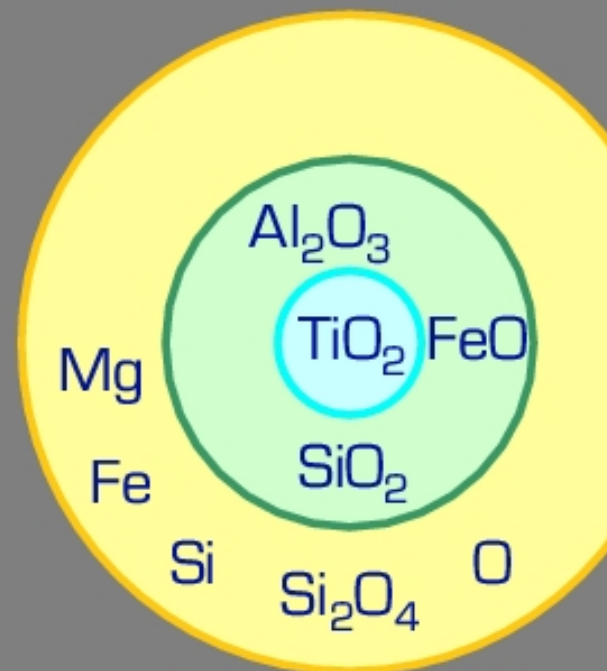
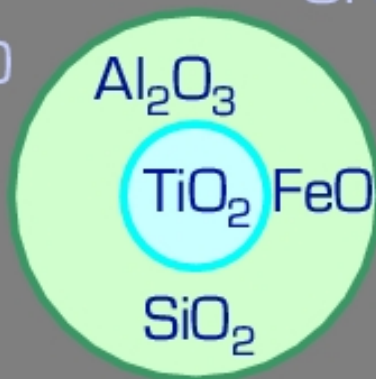


M giant

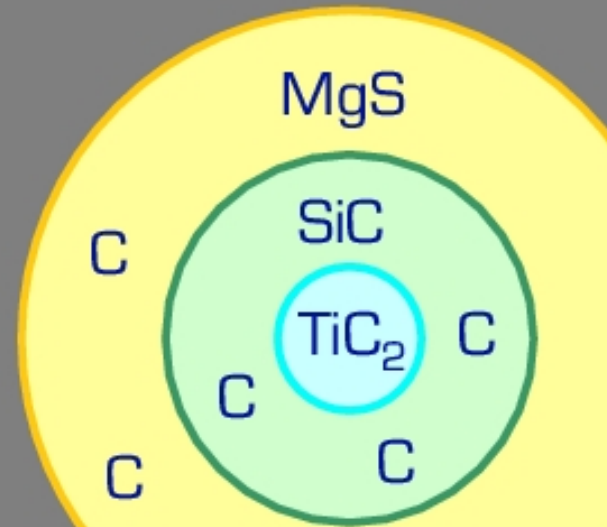
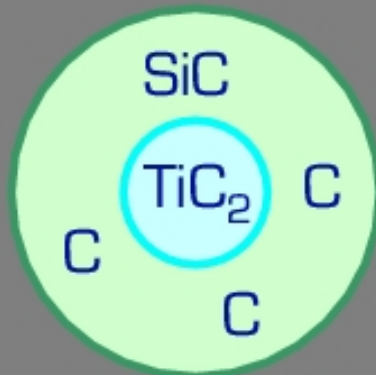
C star

CO CO<sub>2</sub>  
OH H<sub>2</sub>O  
VO  
TiO  
SiO

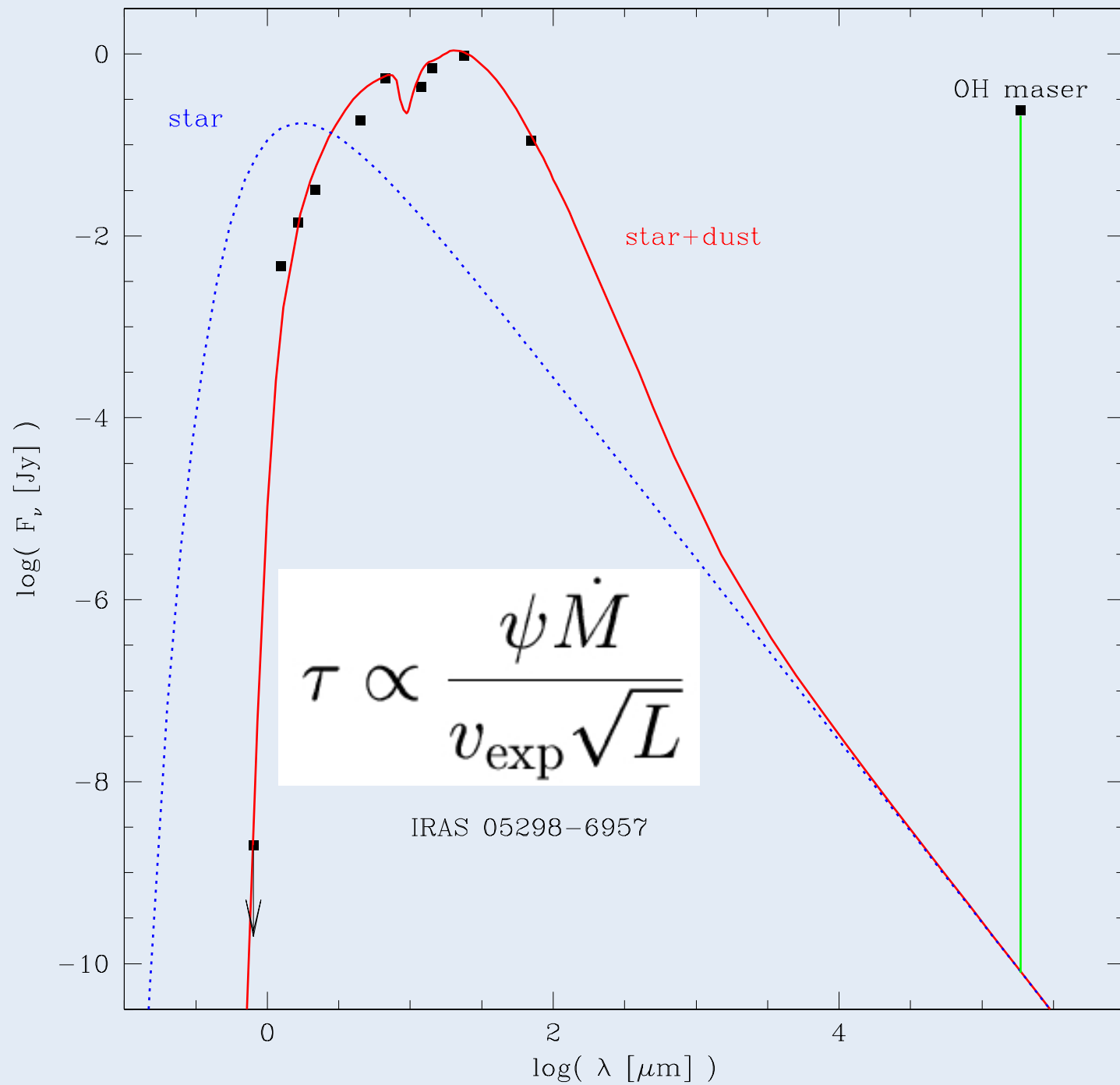
H<sub>2</sub> CO OH  
H<sub>2</sub>O



HCN  
CN  
C<sub>2</sub>

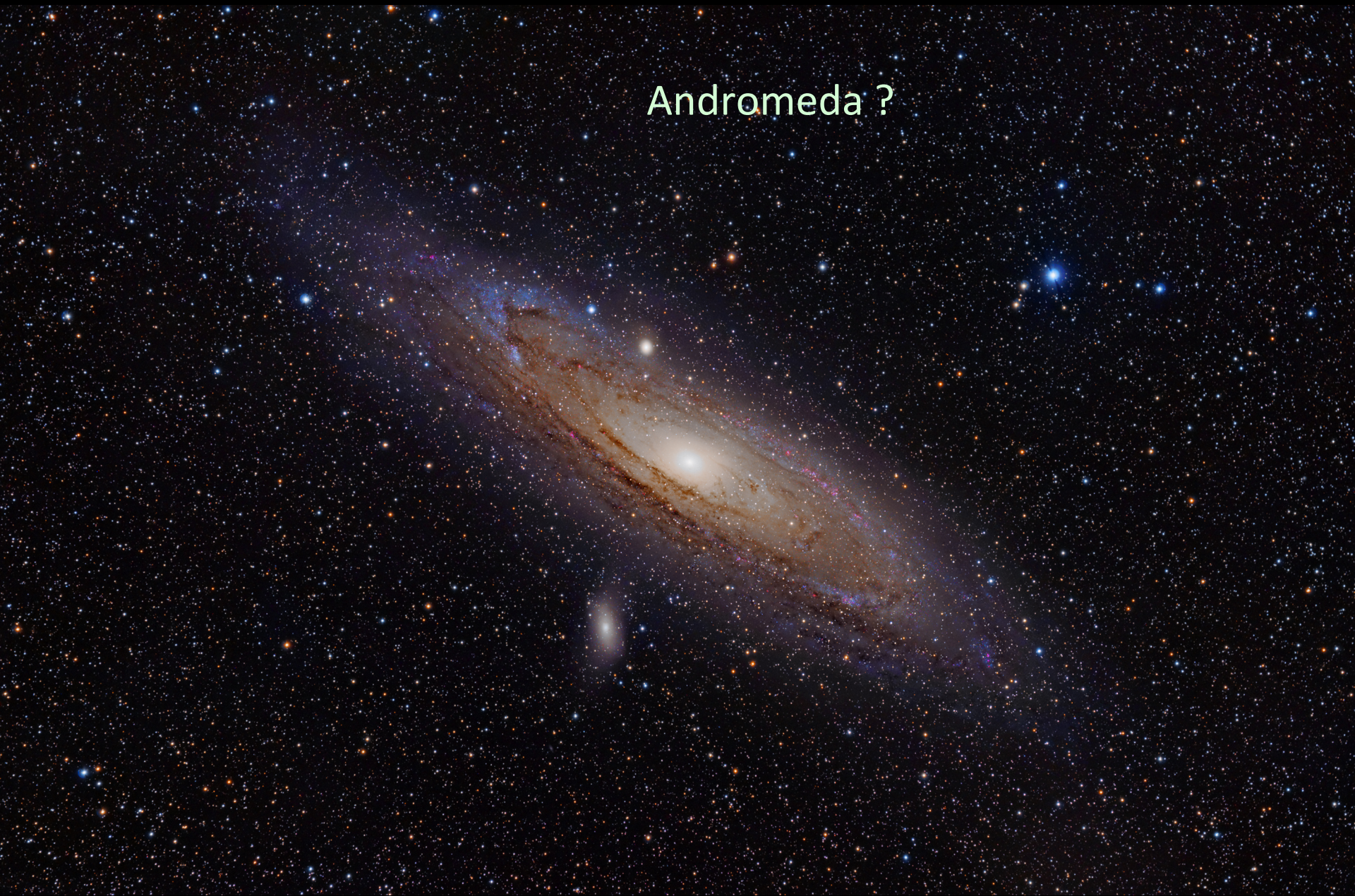


CH C<sub>2</sub>H<sub>2</sub>  
CO C<sub>3</sub>  
C<sub>2</sub>H<sub>2</sub> H<sub>2</sub>  
CO HCN





Andromeda ?



M31

M33



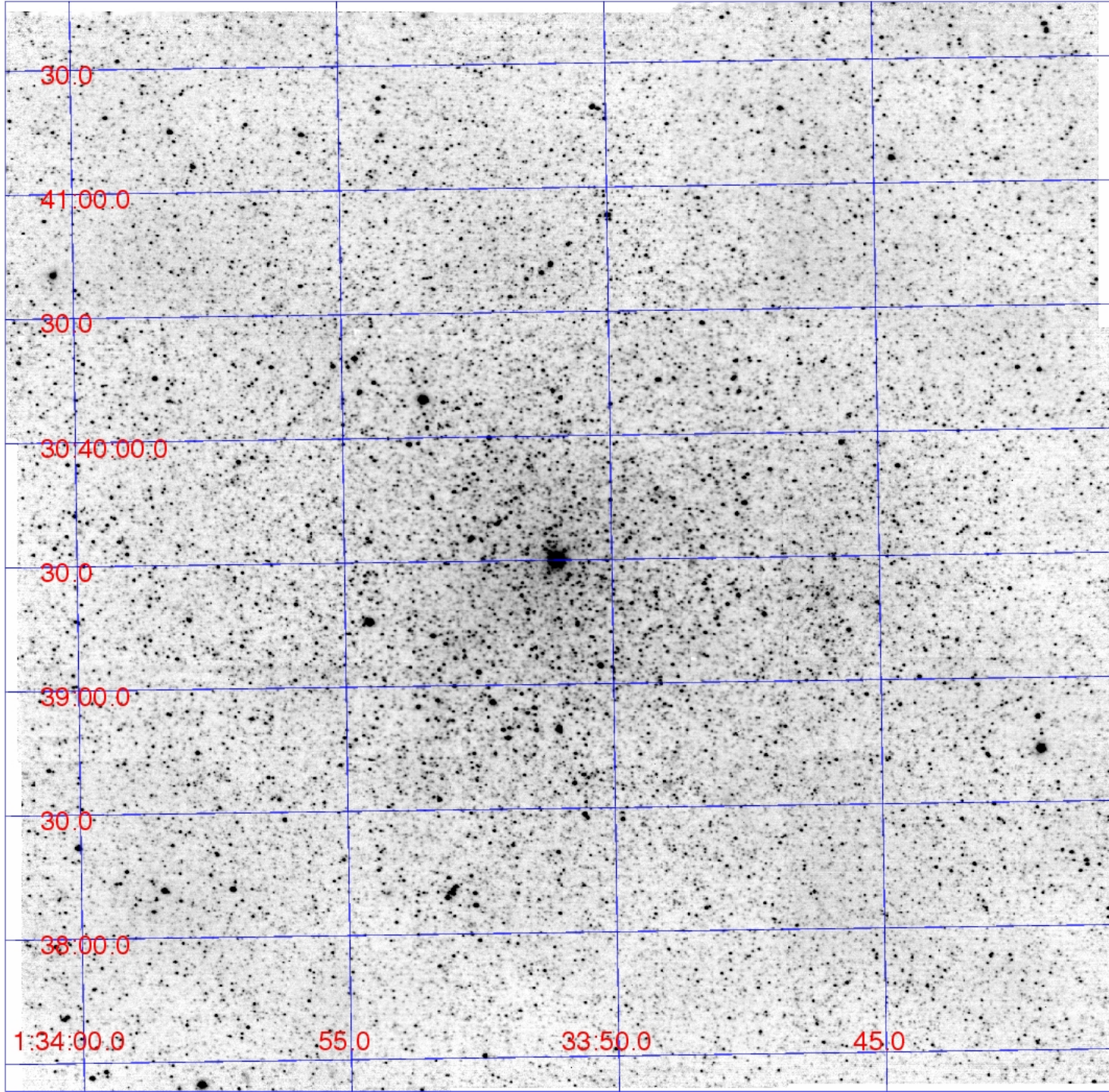
# 3.8m United Kingdom InfraRed Telescope (UKIRT)

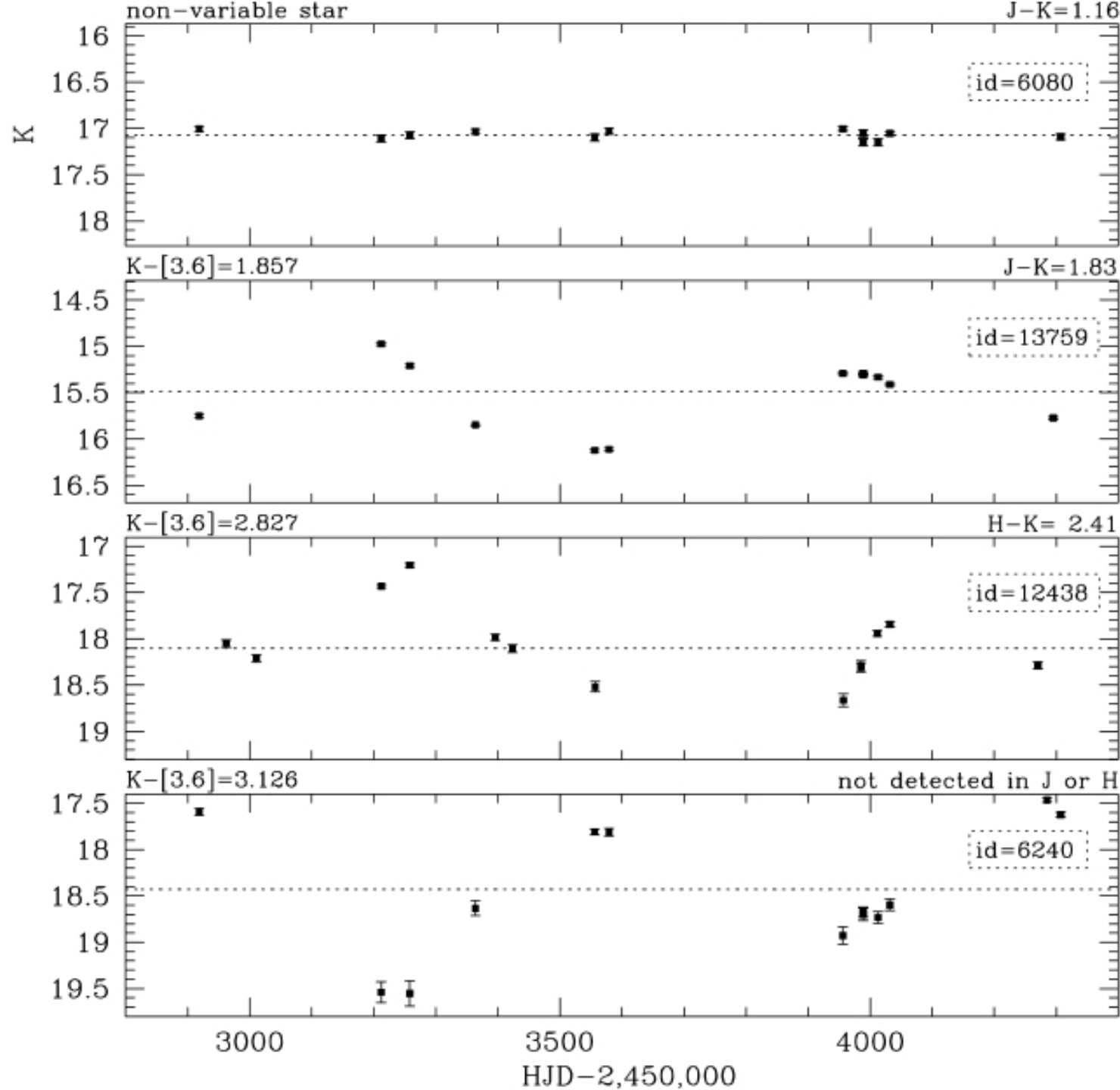


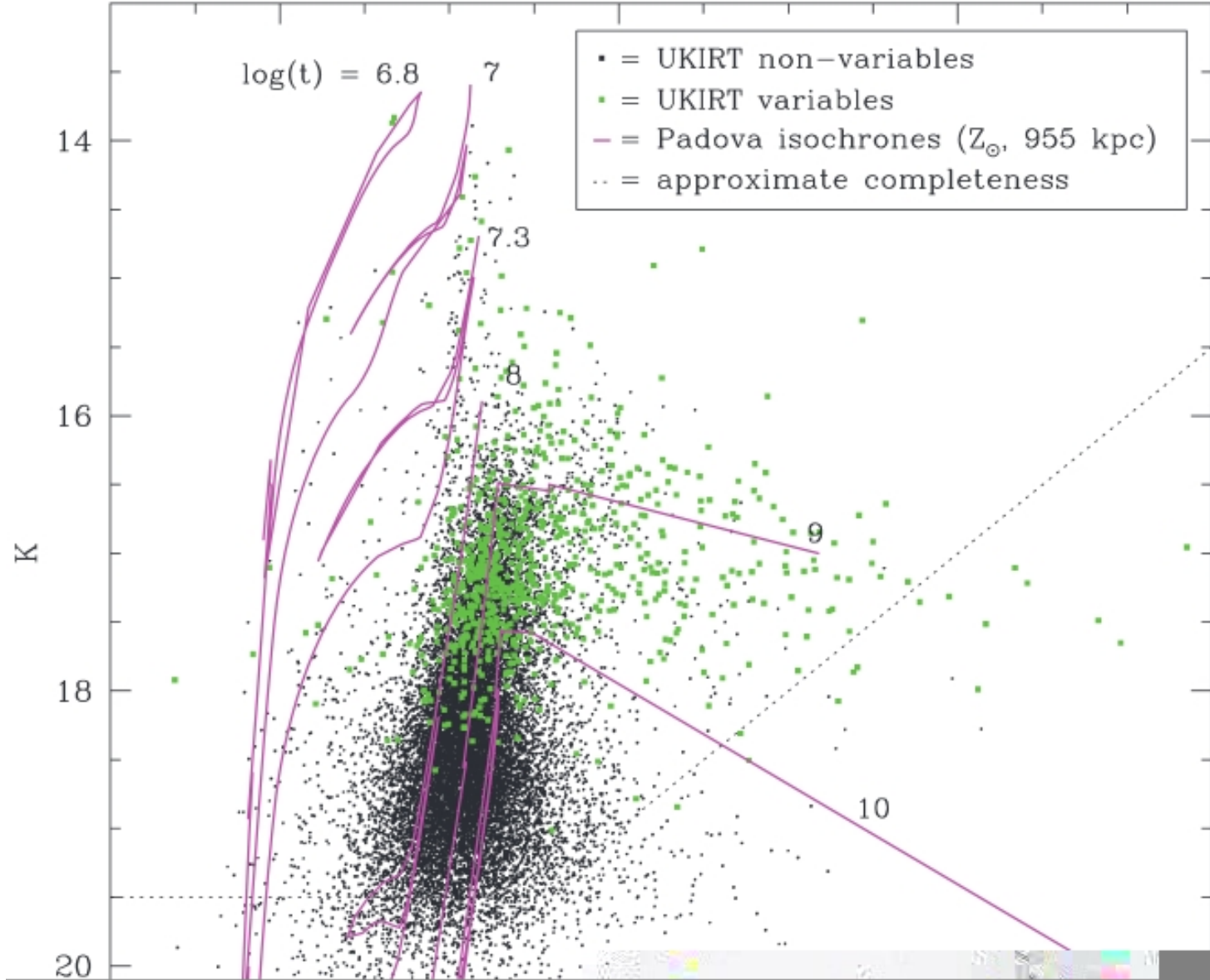


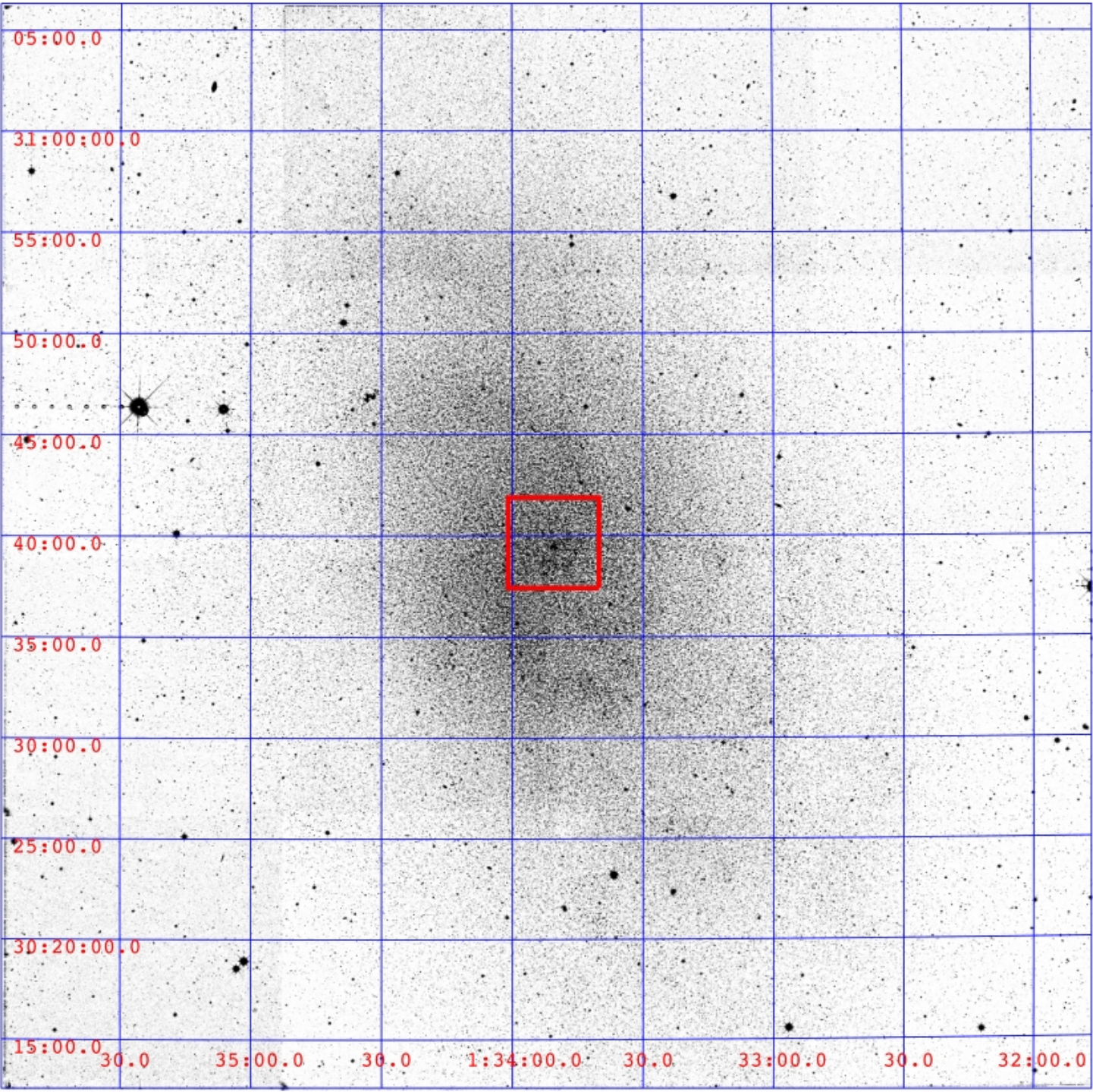
Dr. Atefeh Javadi  
IPM, Tehran  
(Iran)

Javadi et al. 2011a  
Javadi et al. 2011b  
Javadi et al. 2013  
Javadi et al. 2015  
Javadi et al. 2016  
Javadi et al. in prep

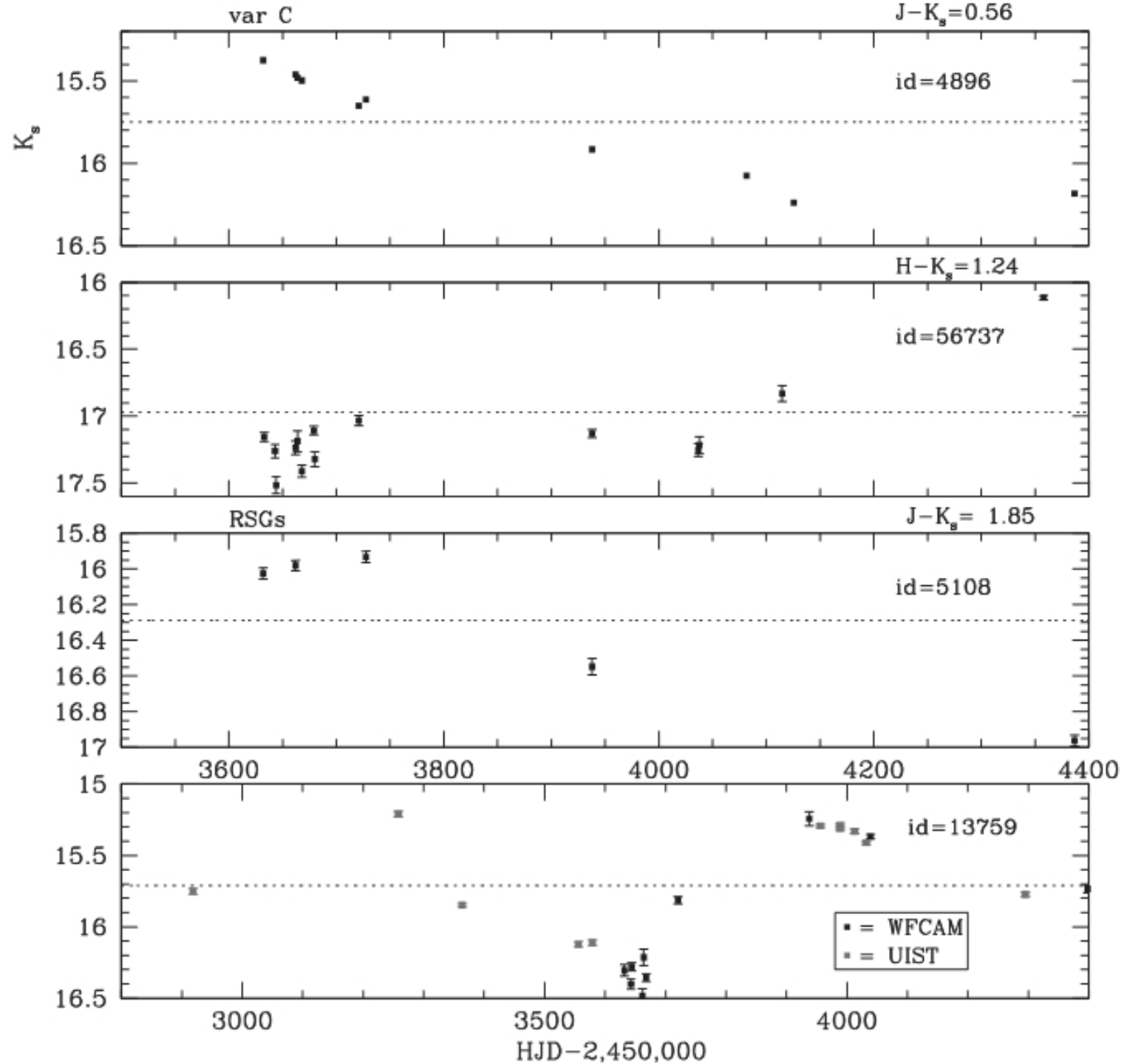


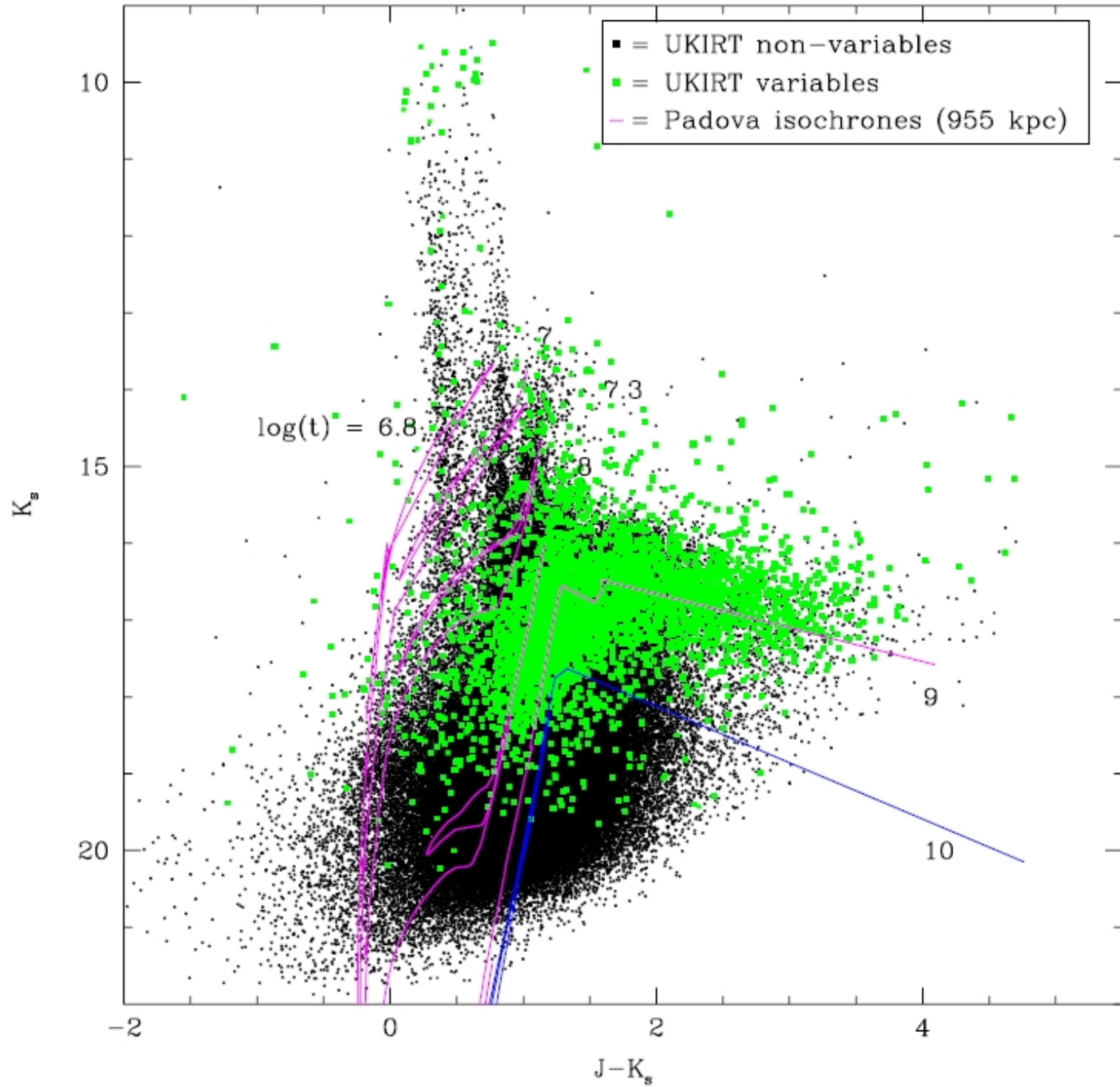


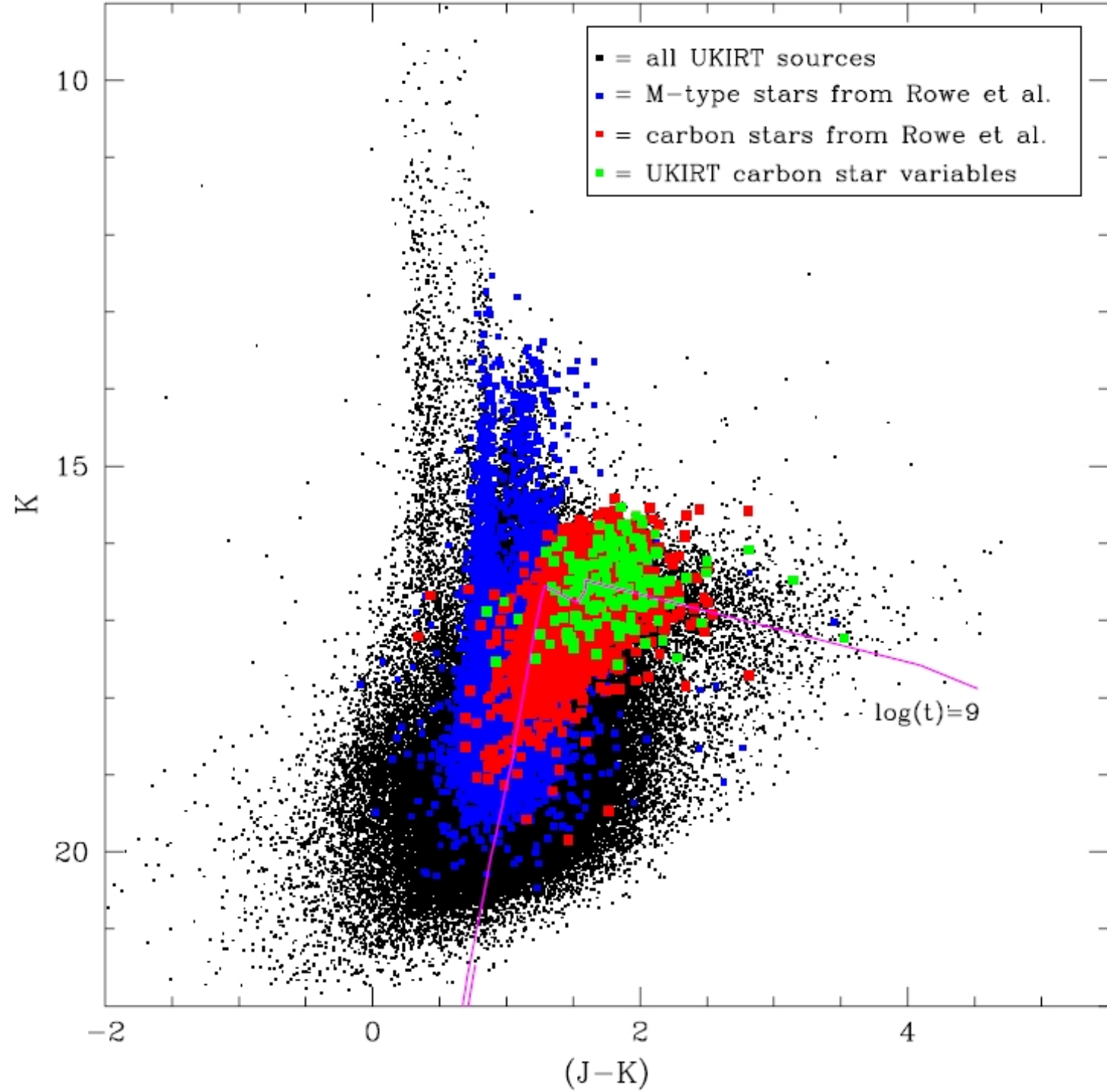


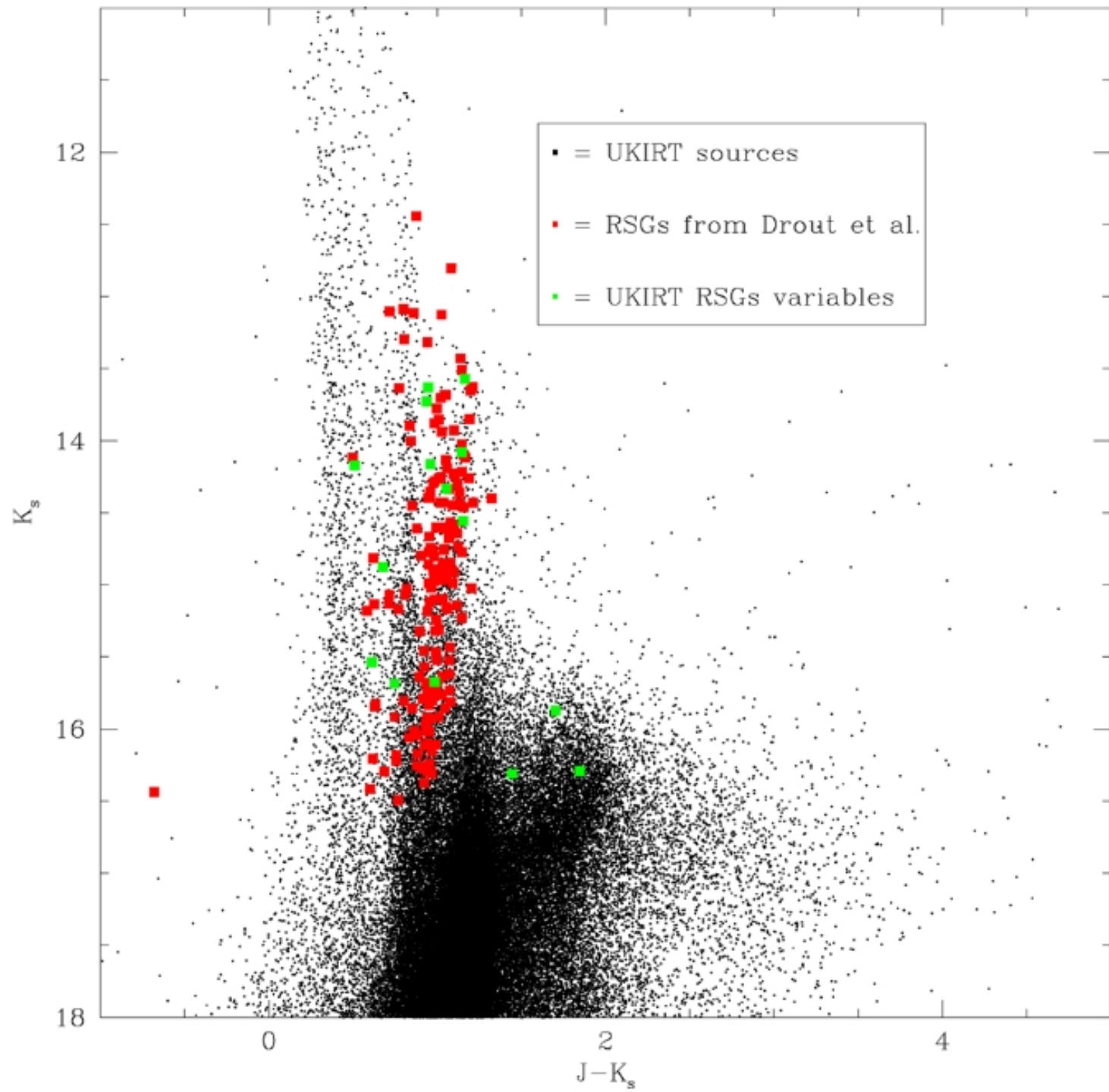


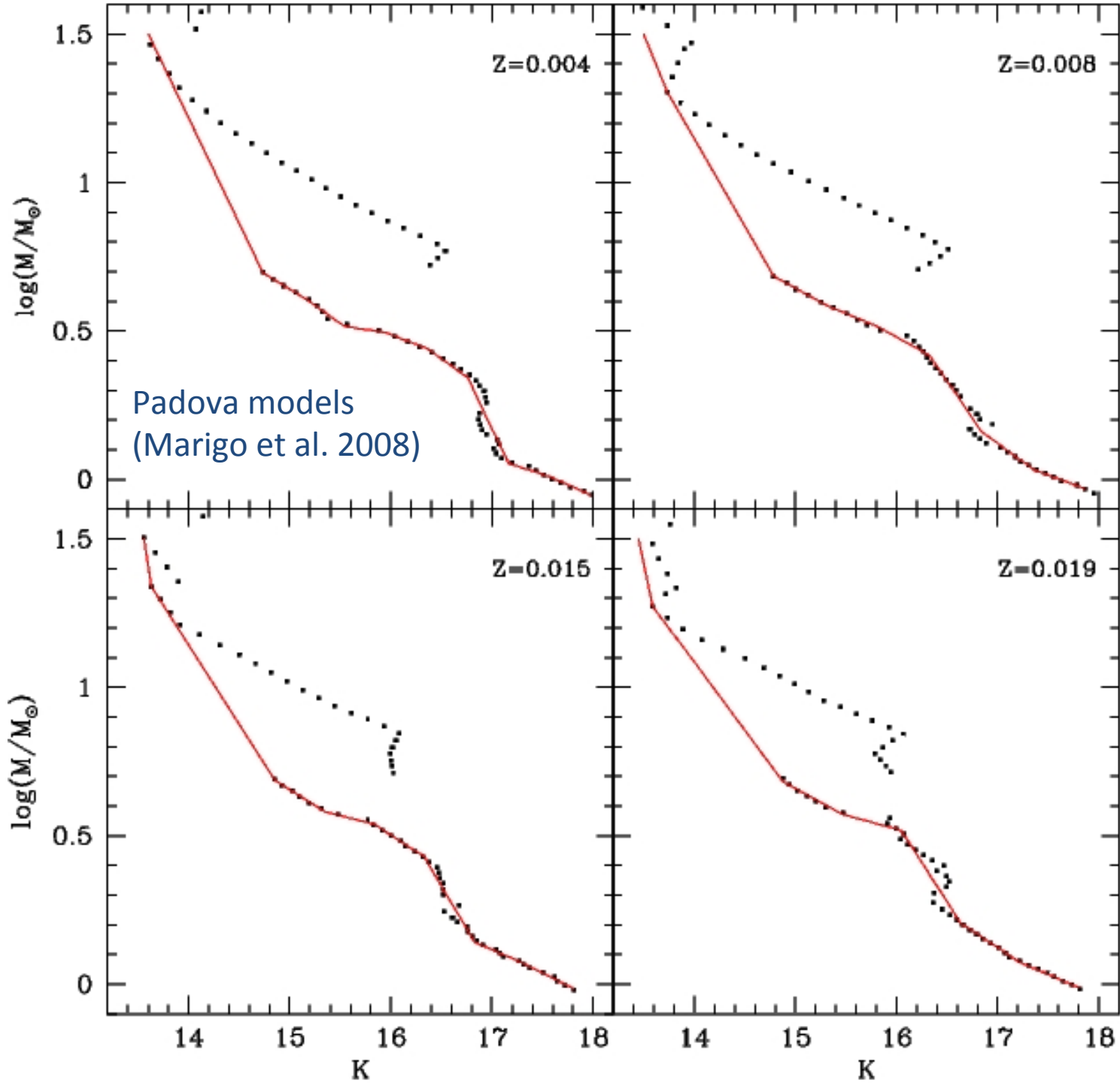


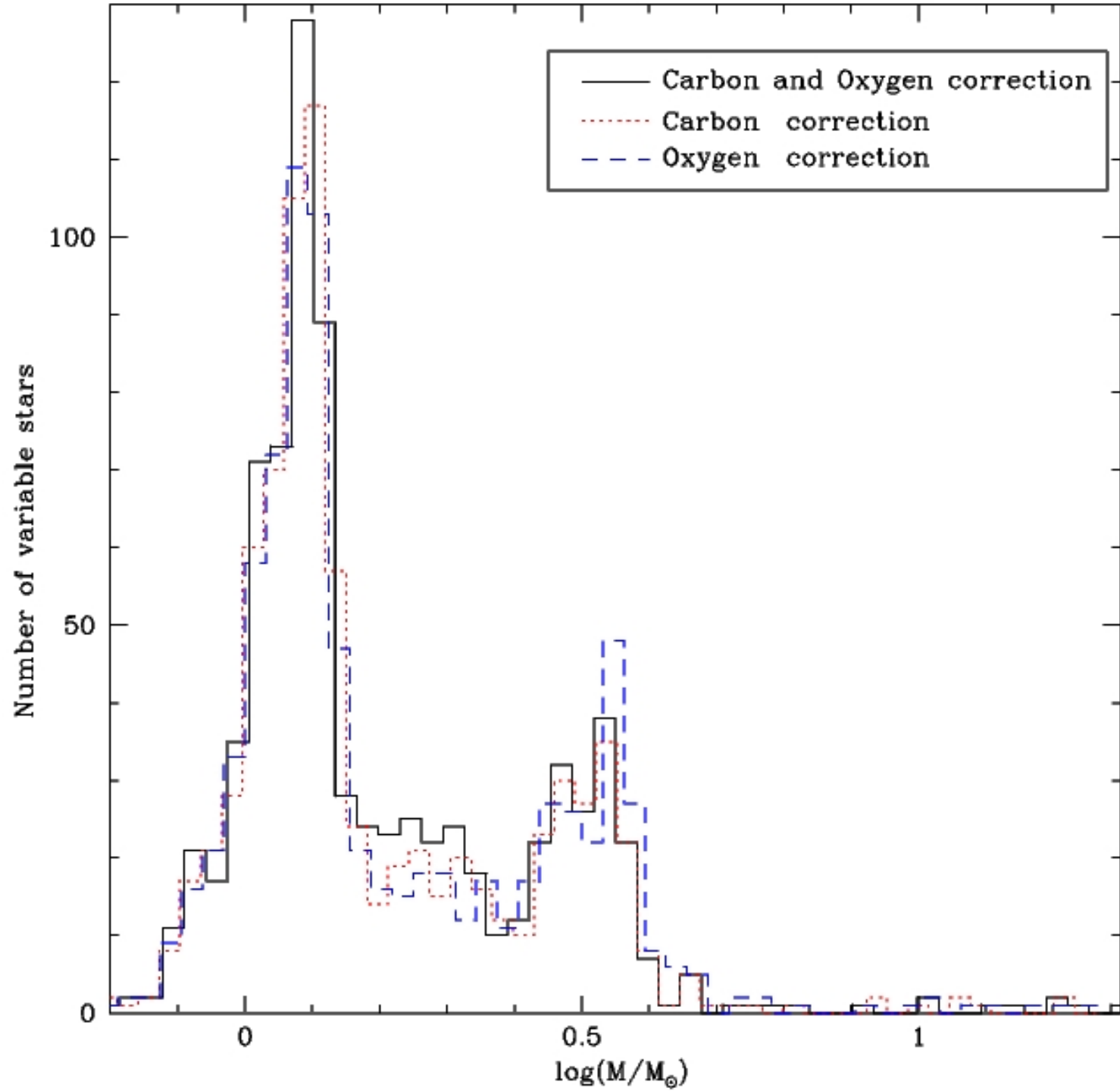


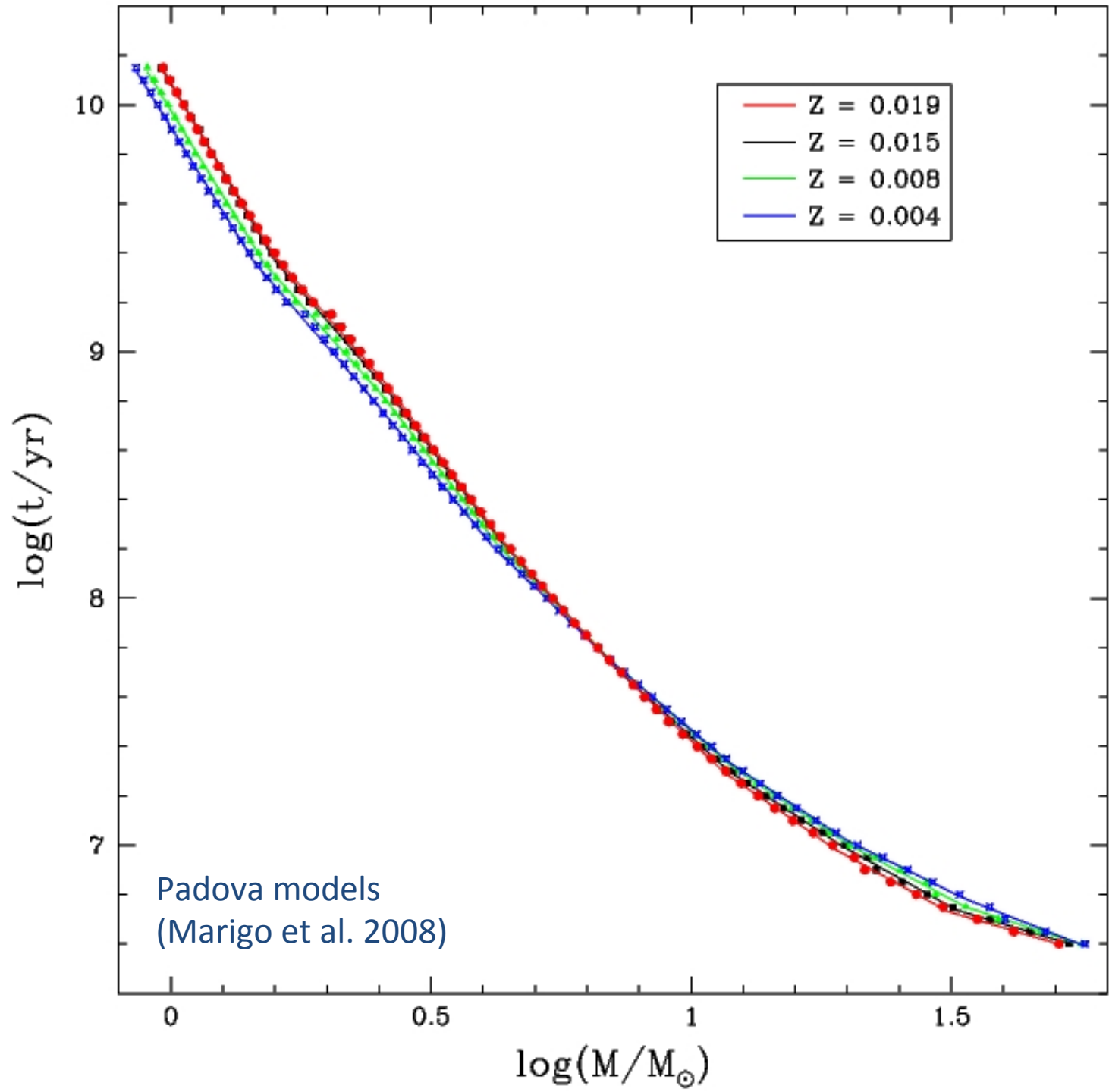


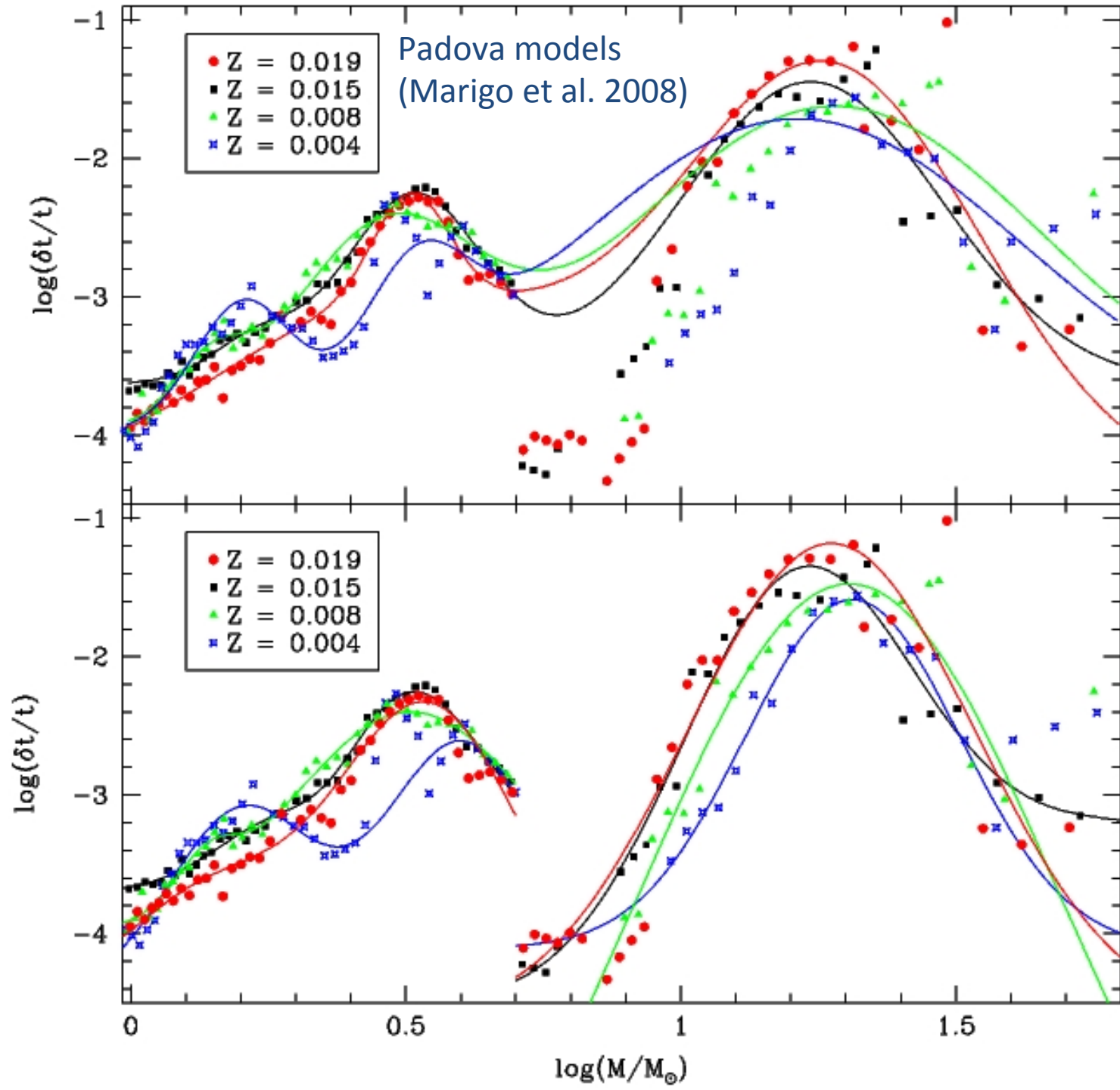






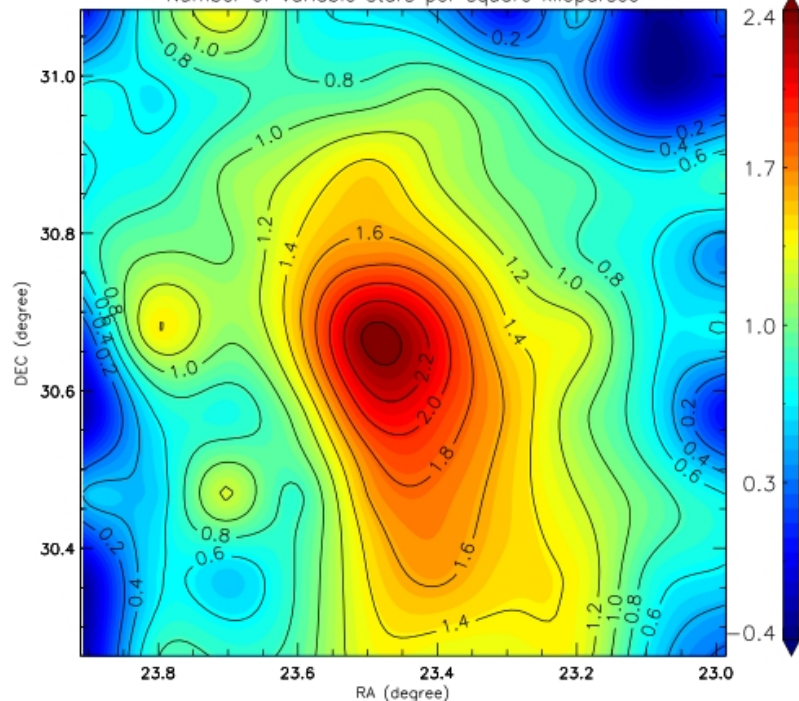




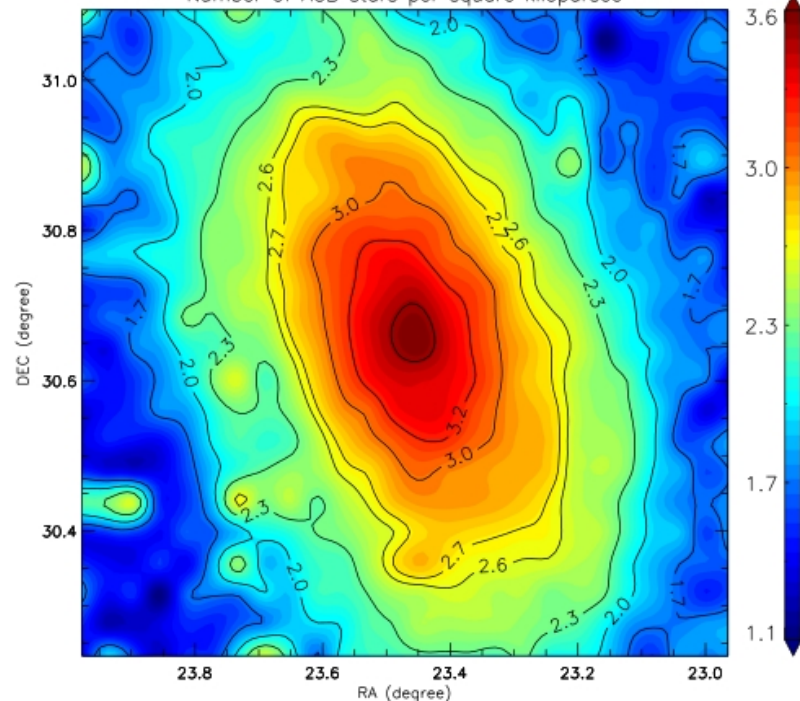




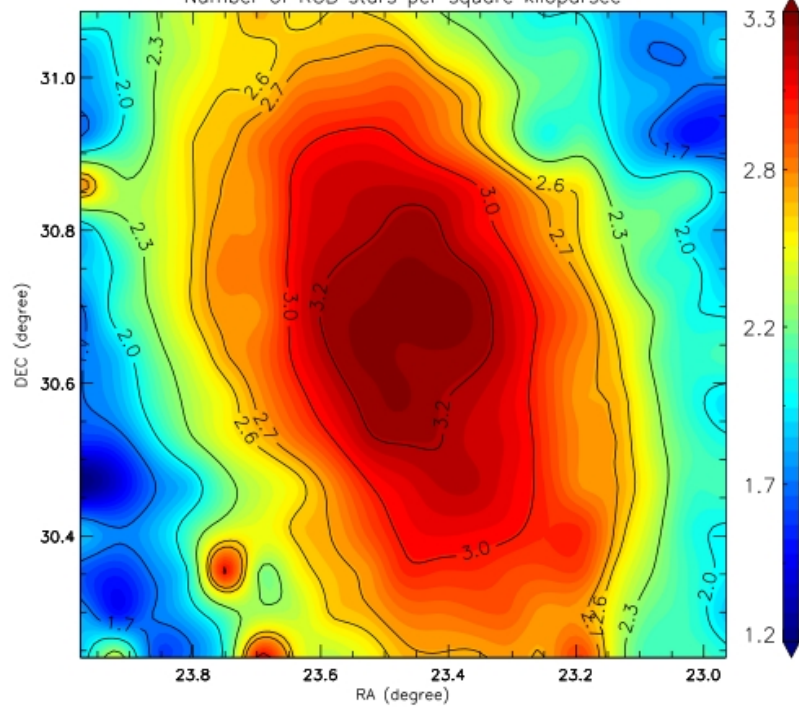
Number of variable stars per square kiloparsec



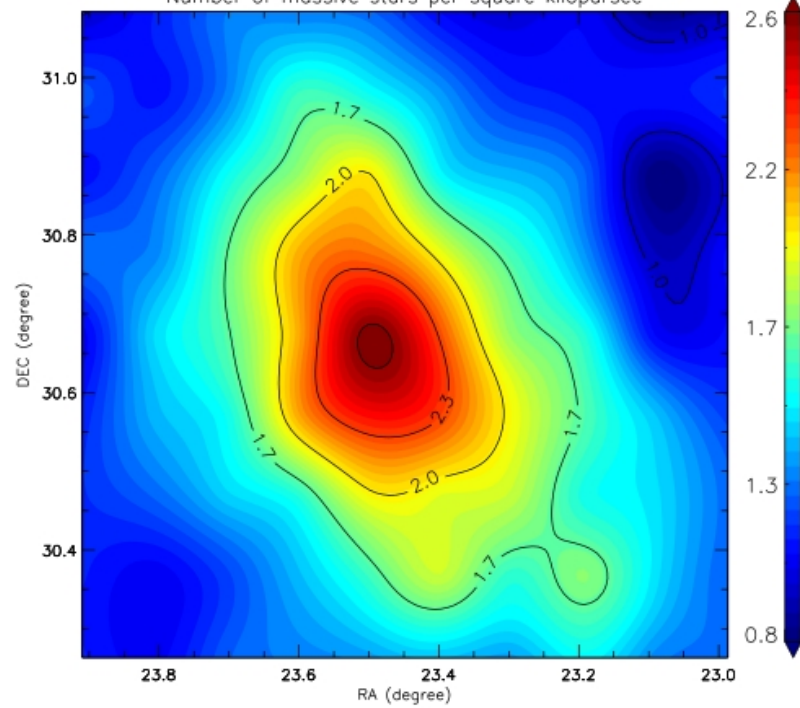
Number of AGB stars per square kiloparsec

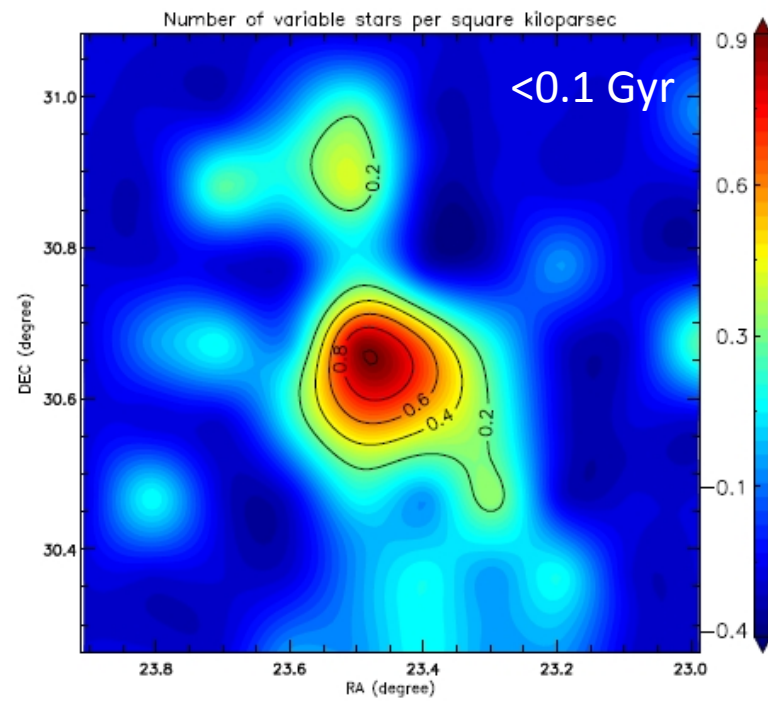
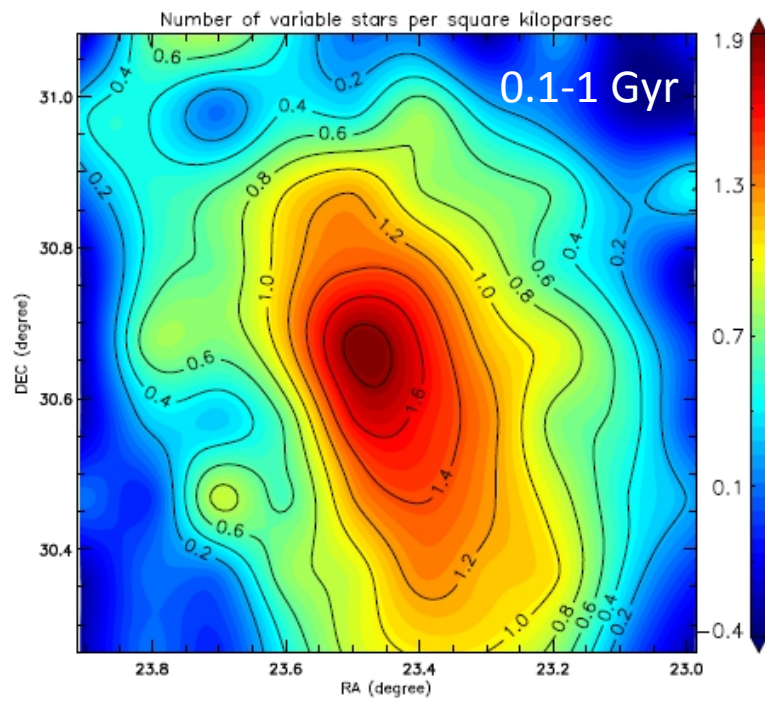
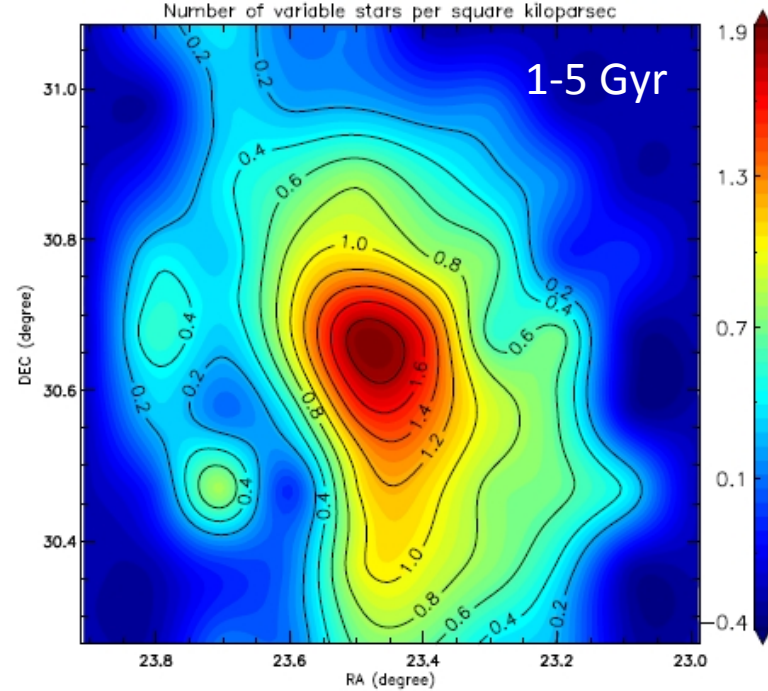
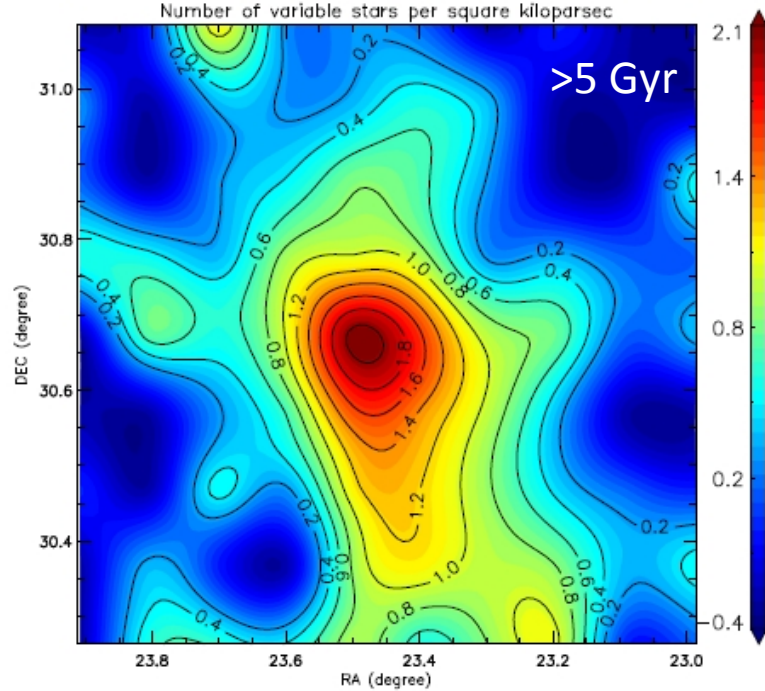


Number of RGB stars per square kiloparsec

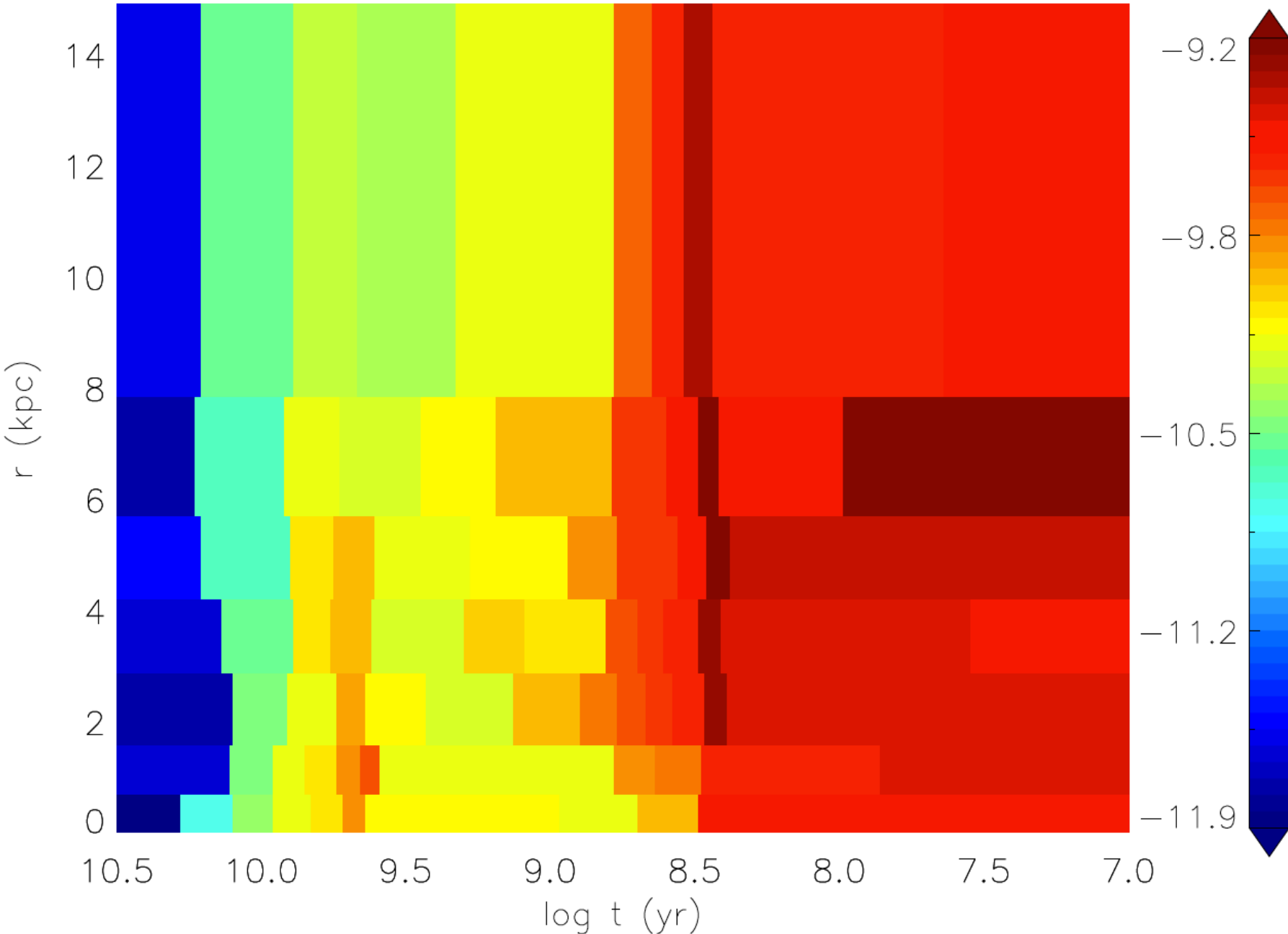


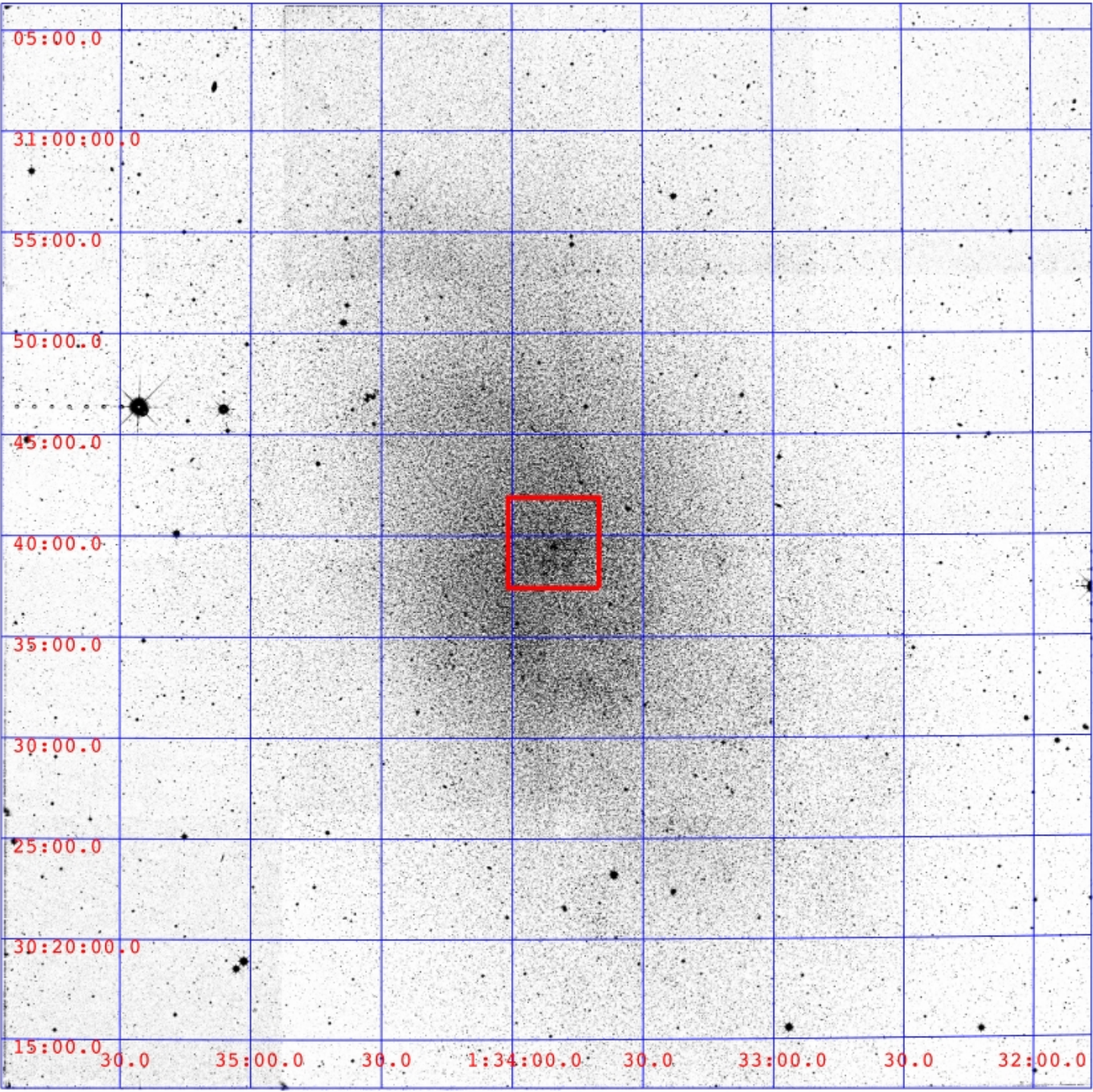
Number of massive stars per square kiloparsec





# star formation history (fraction of total stellar mass as it formed each year)



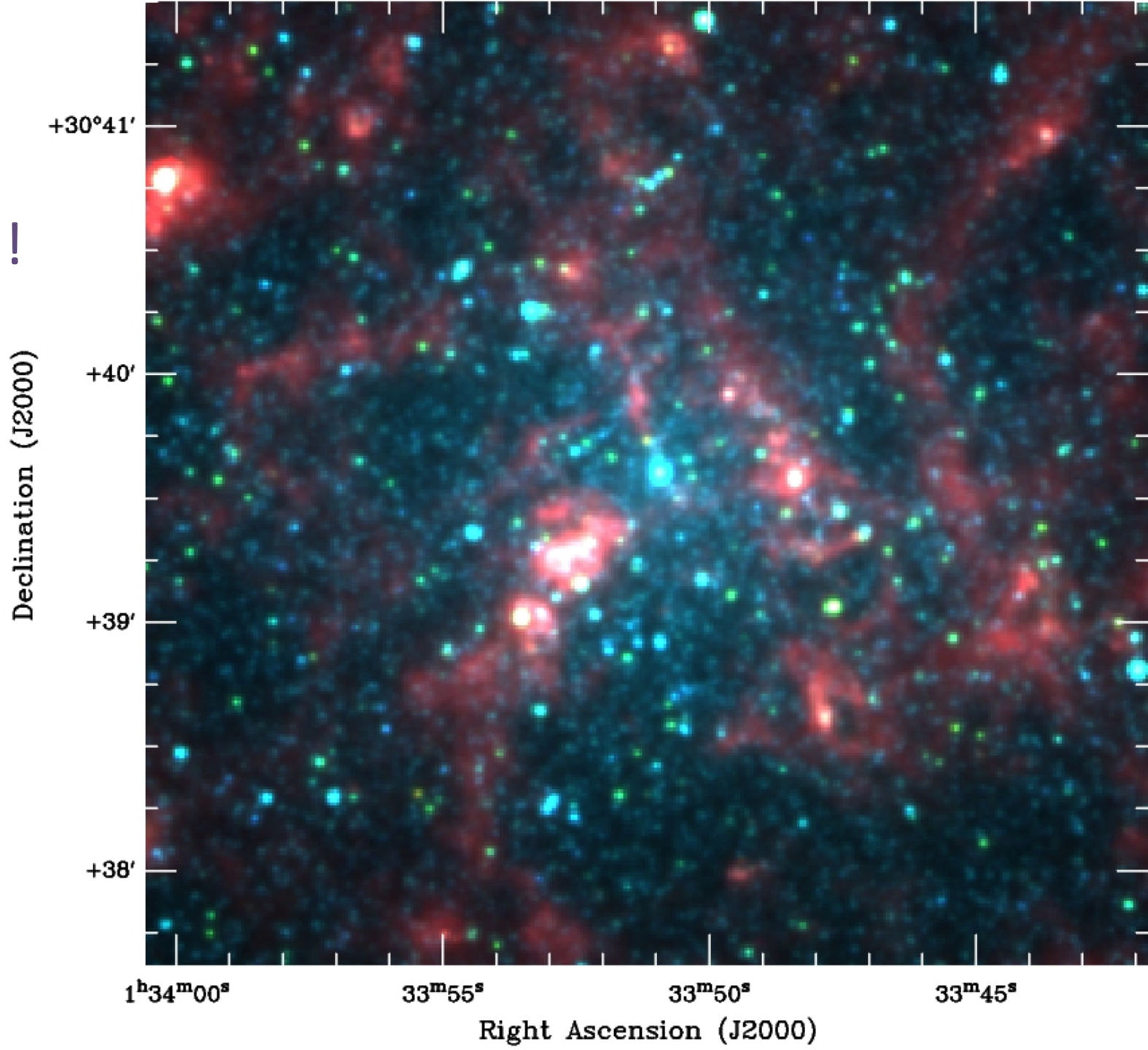


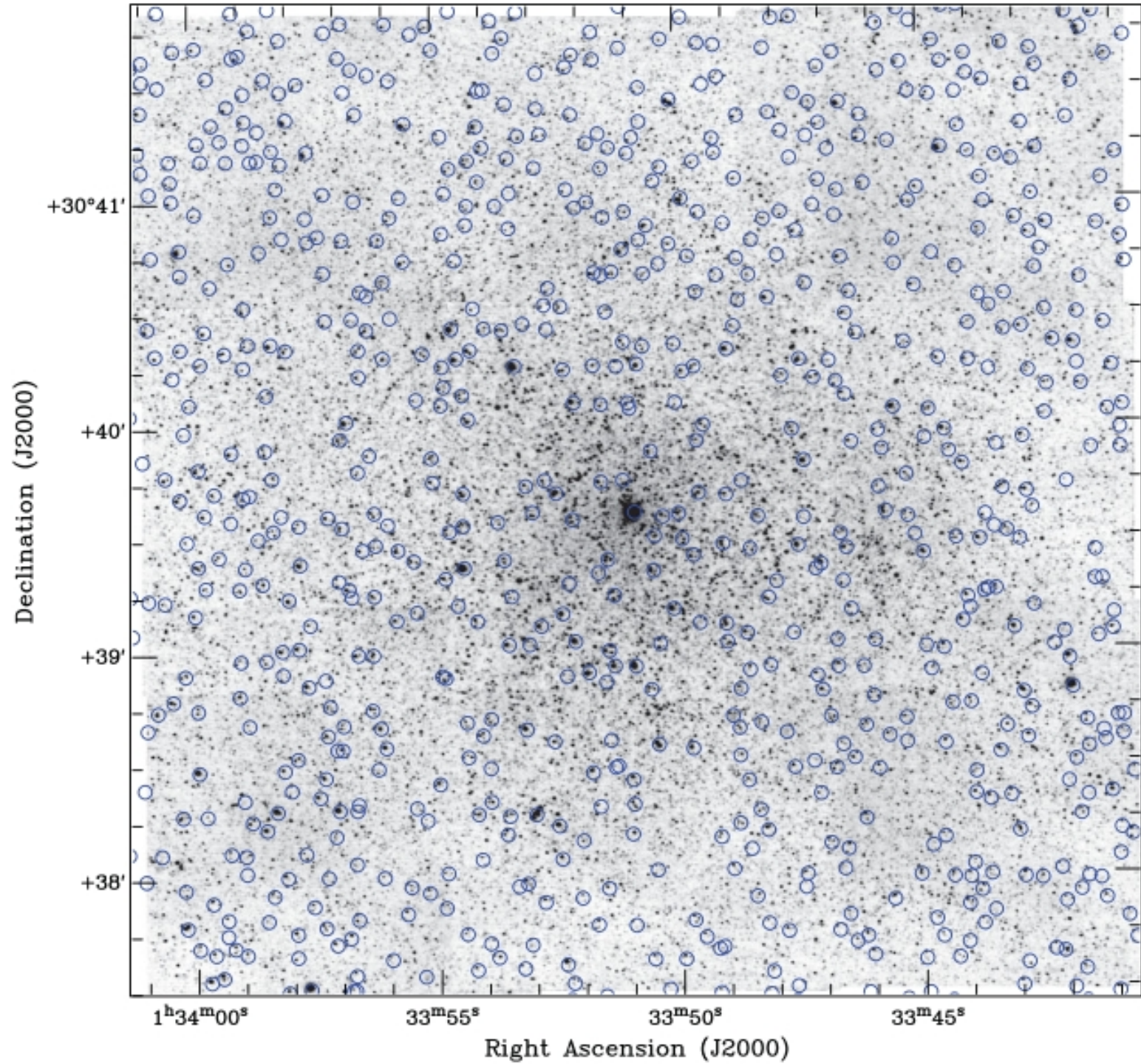
# Spitzer Early Science !

3.6  $\mu\text{m}$

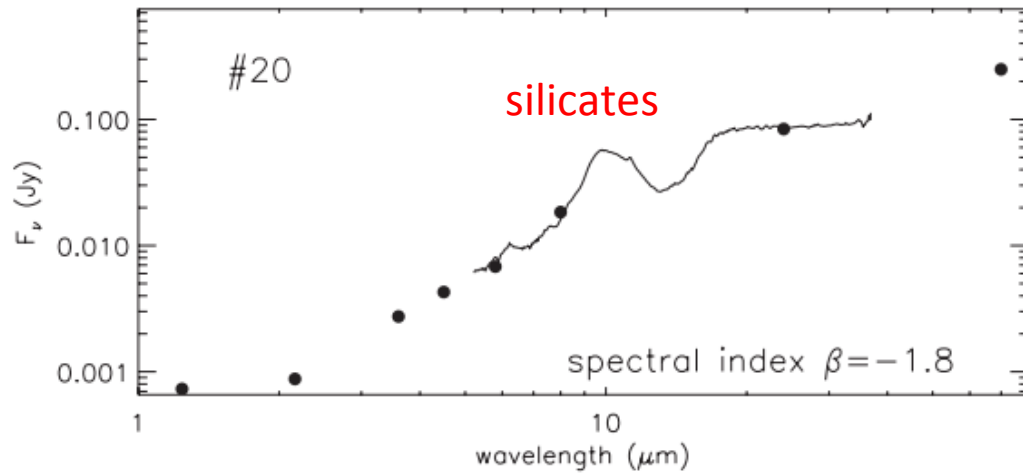
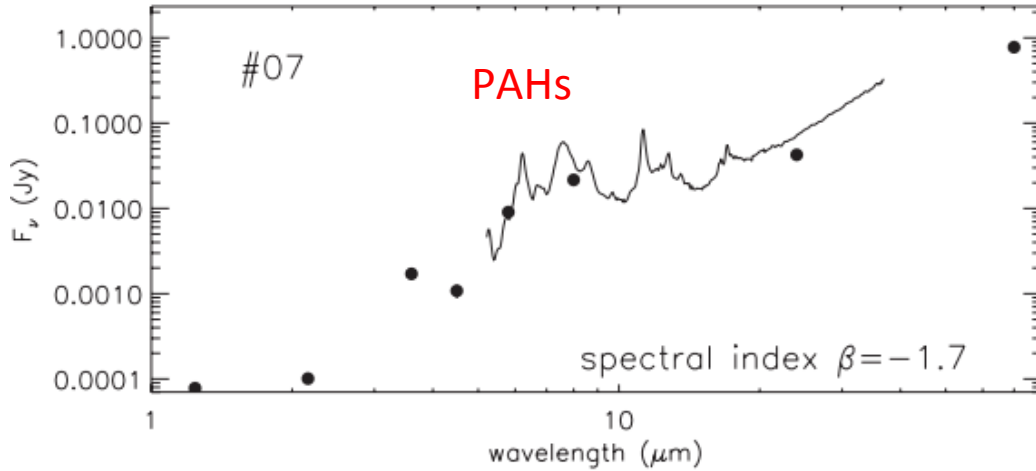
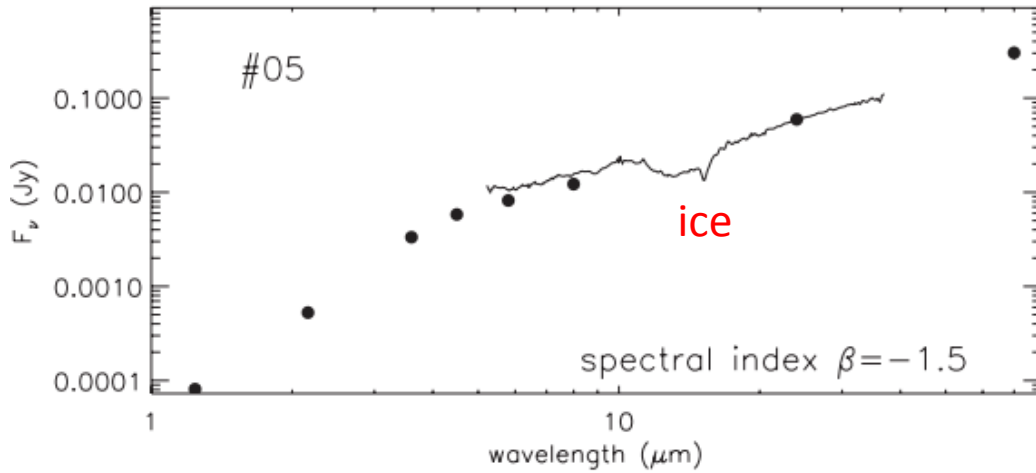
4.5  $\mu\text{m}$

8  $\mu\text{m}$

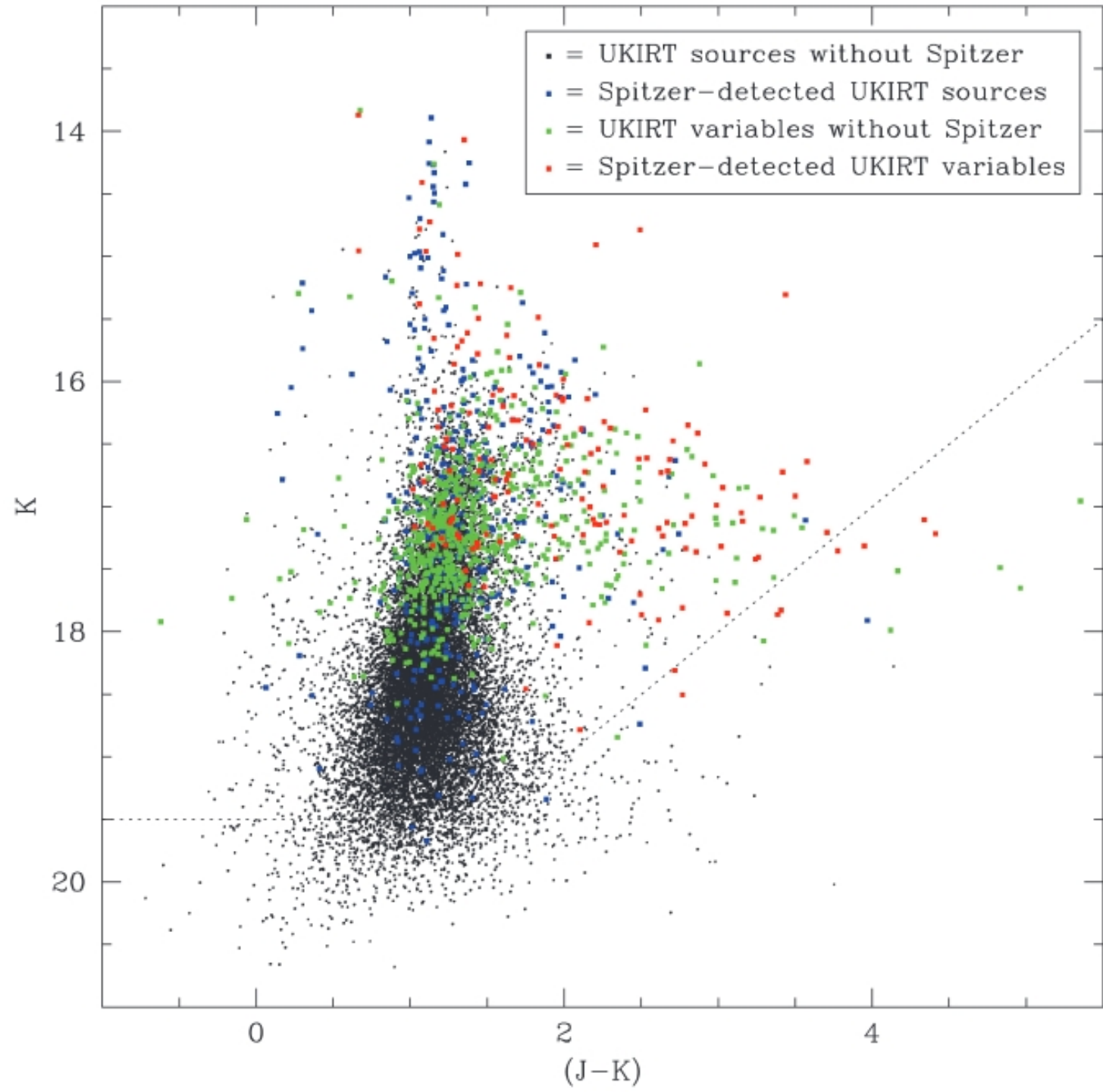




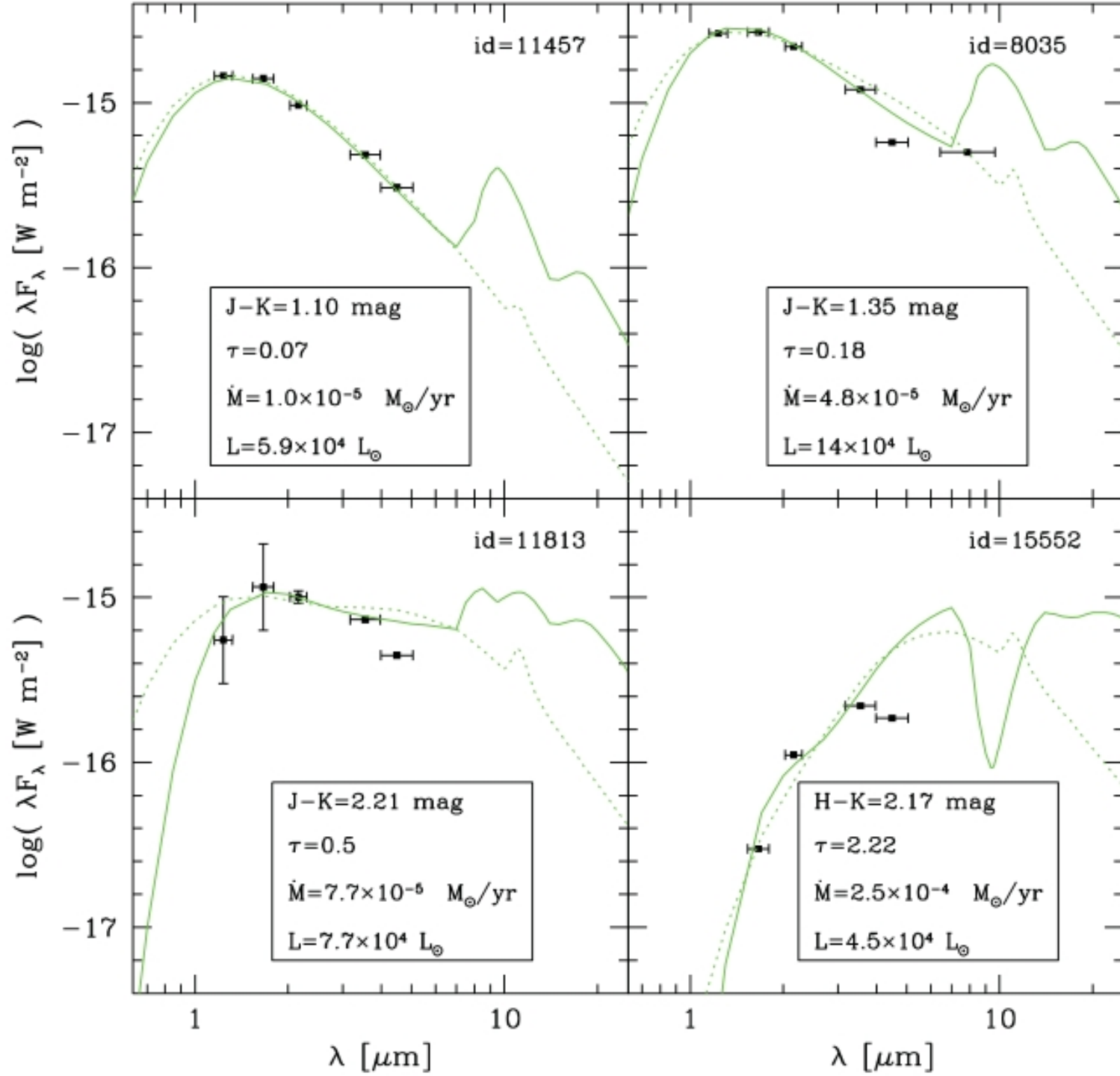
what about  
young stellar objects  
?

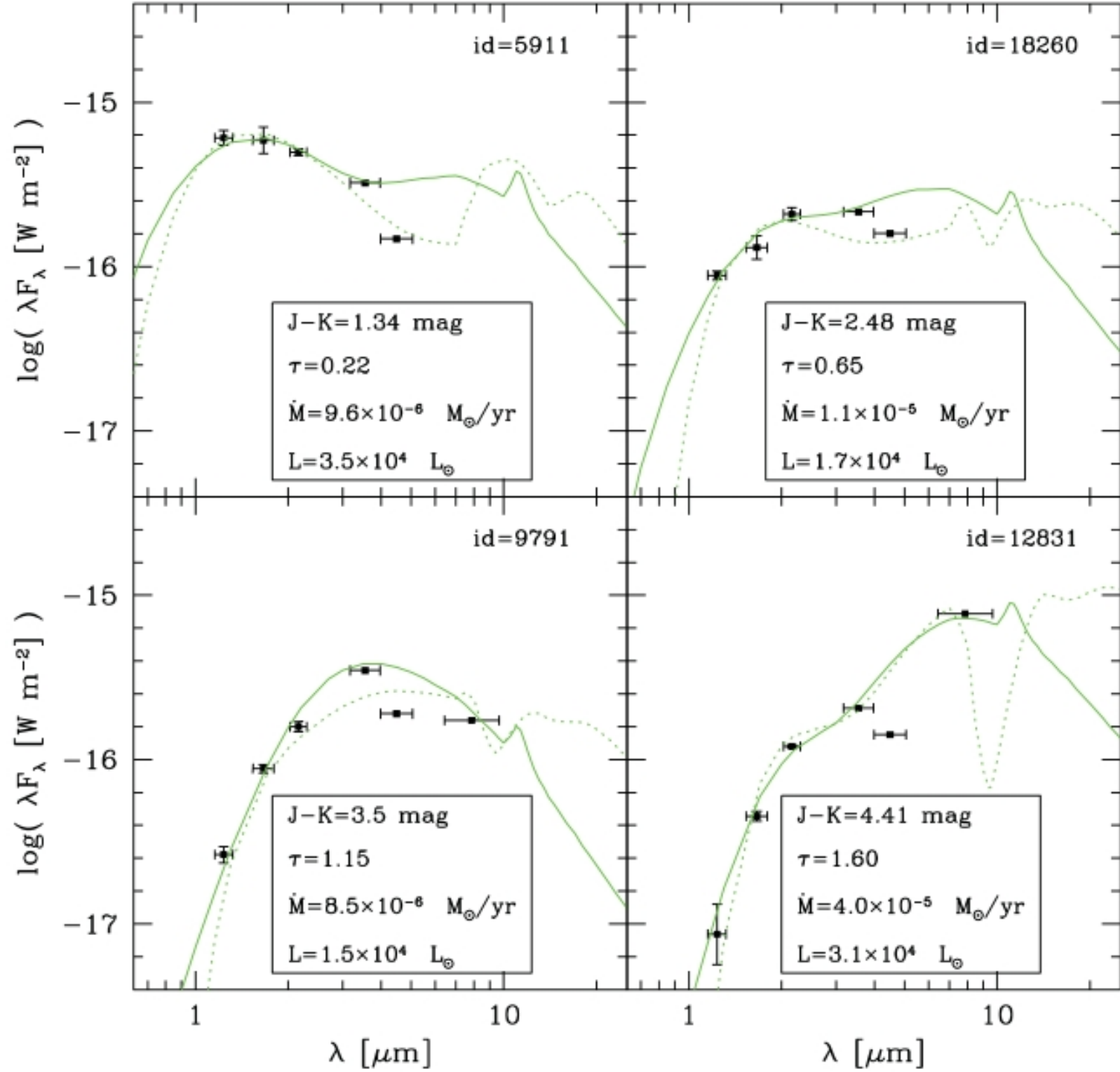


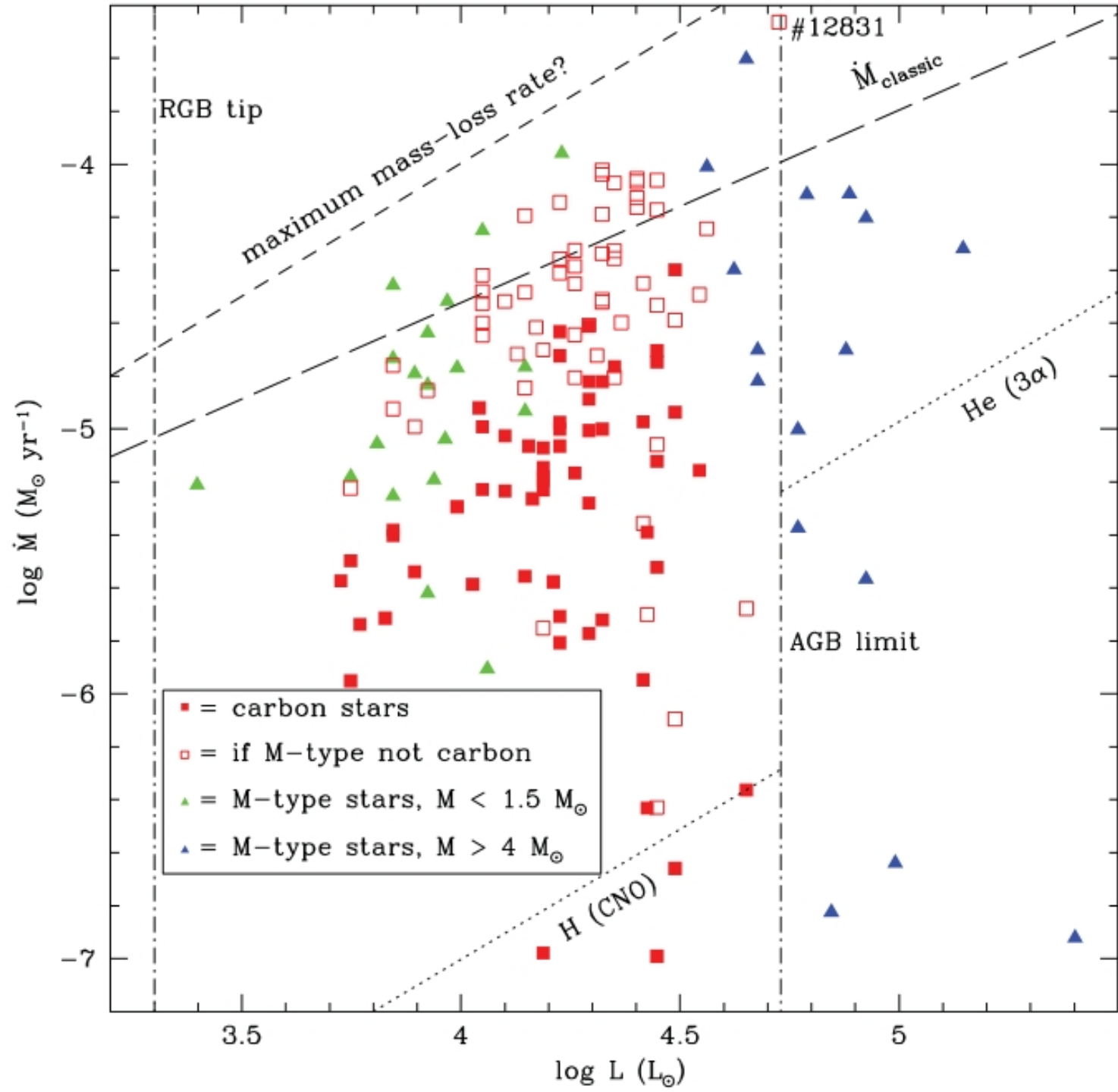
examples in the SMC  
(Oliveira et al. 2013)

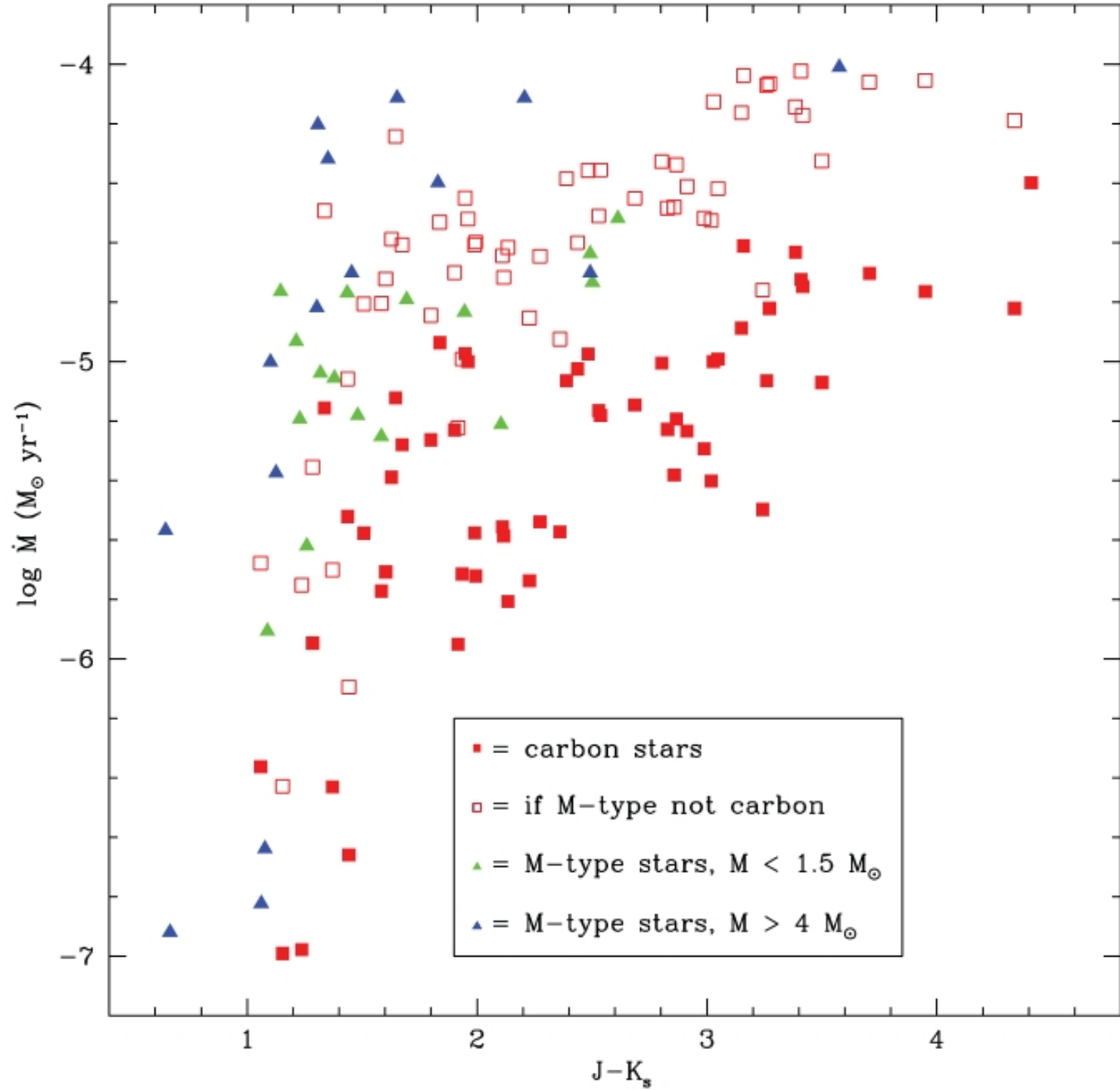


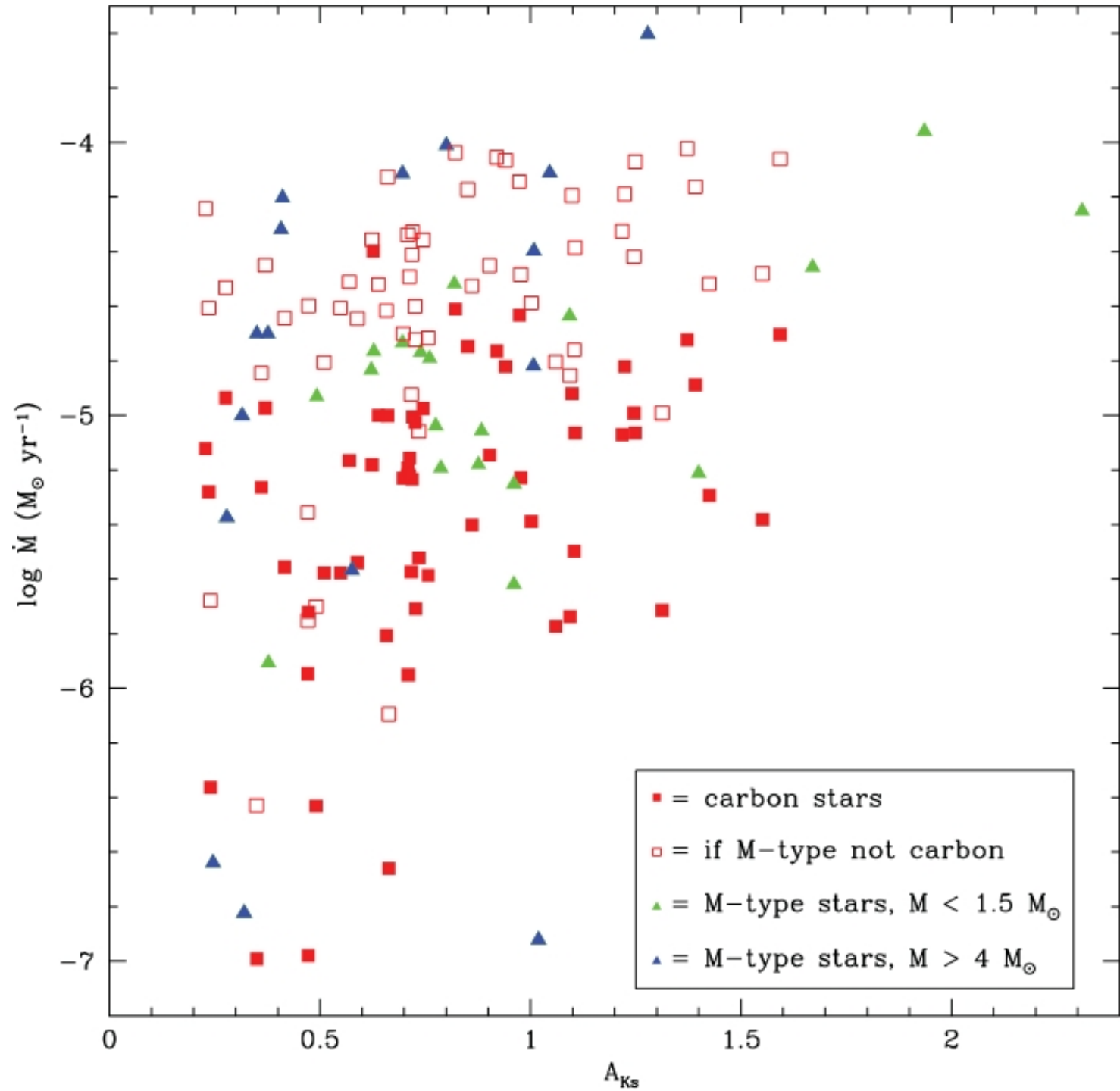


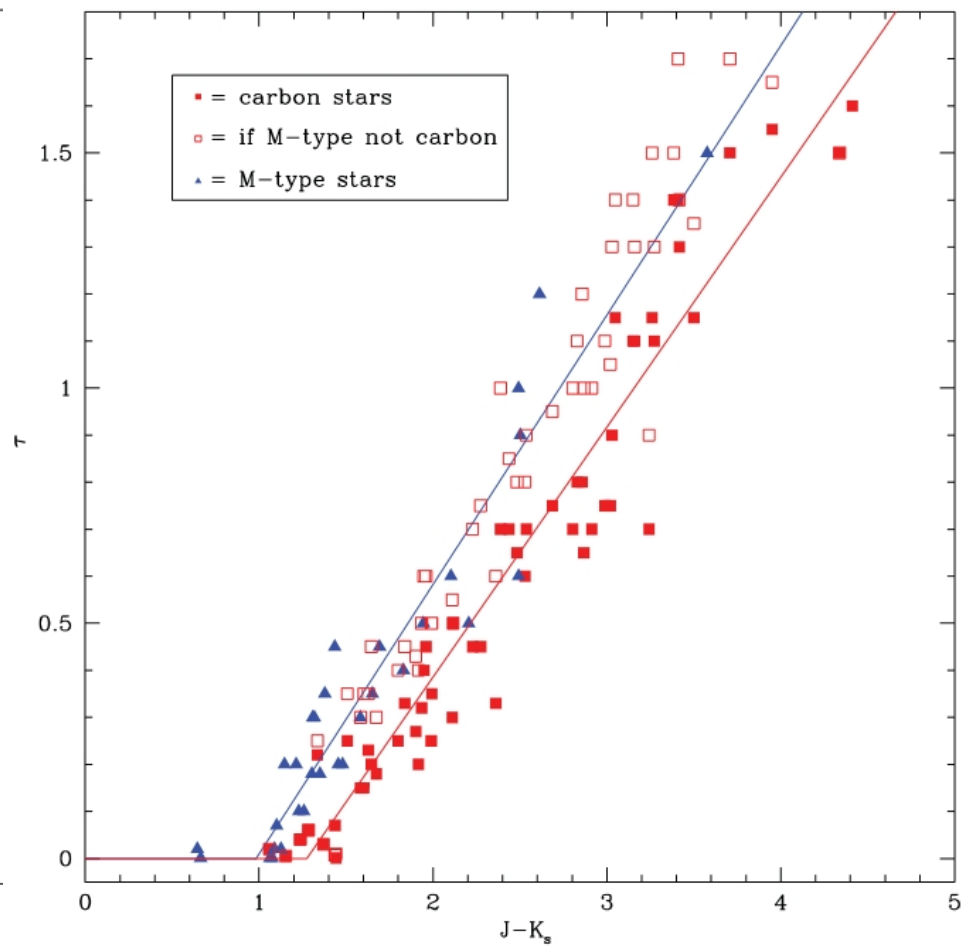
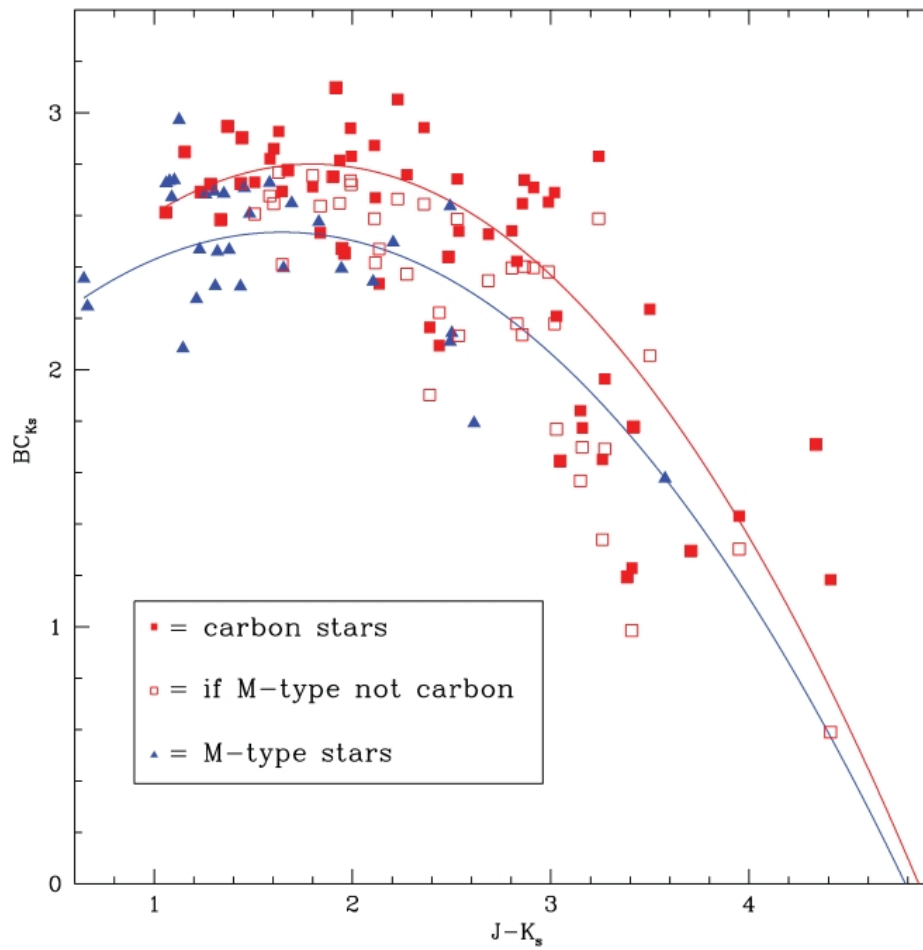




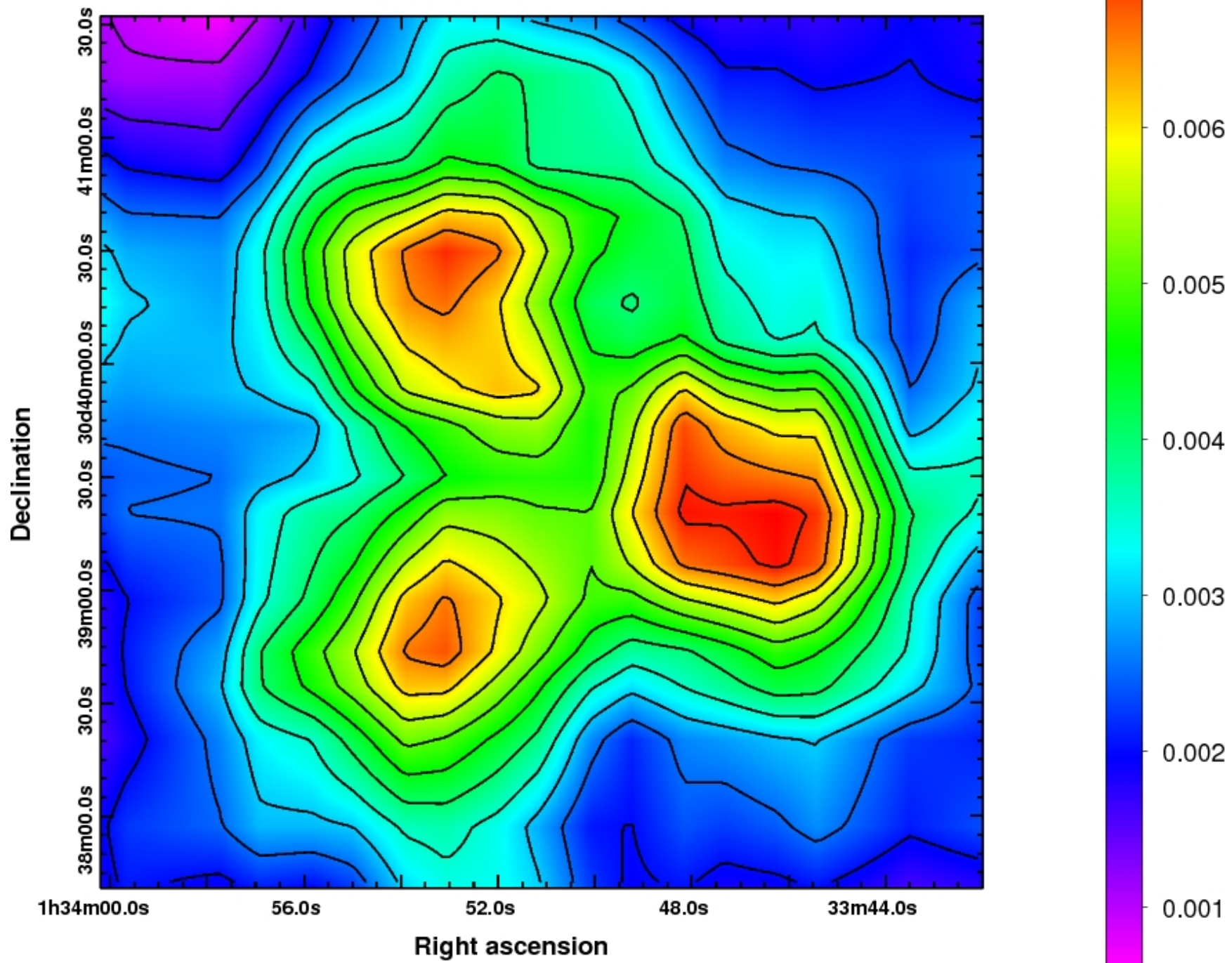


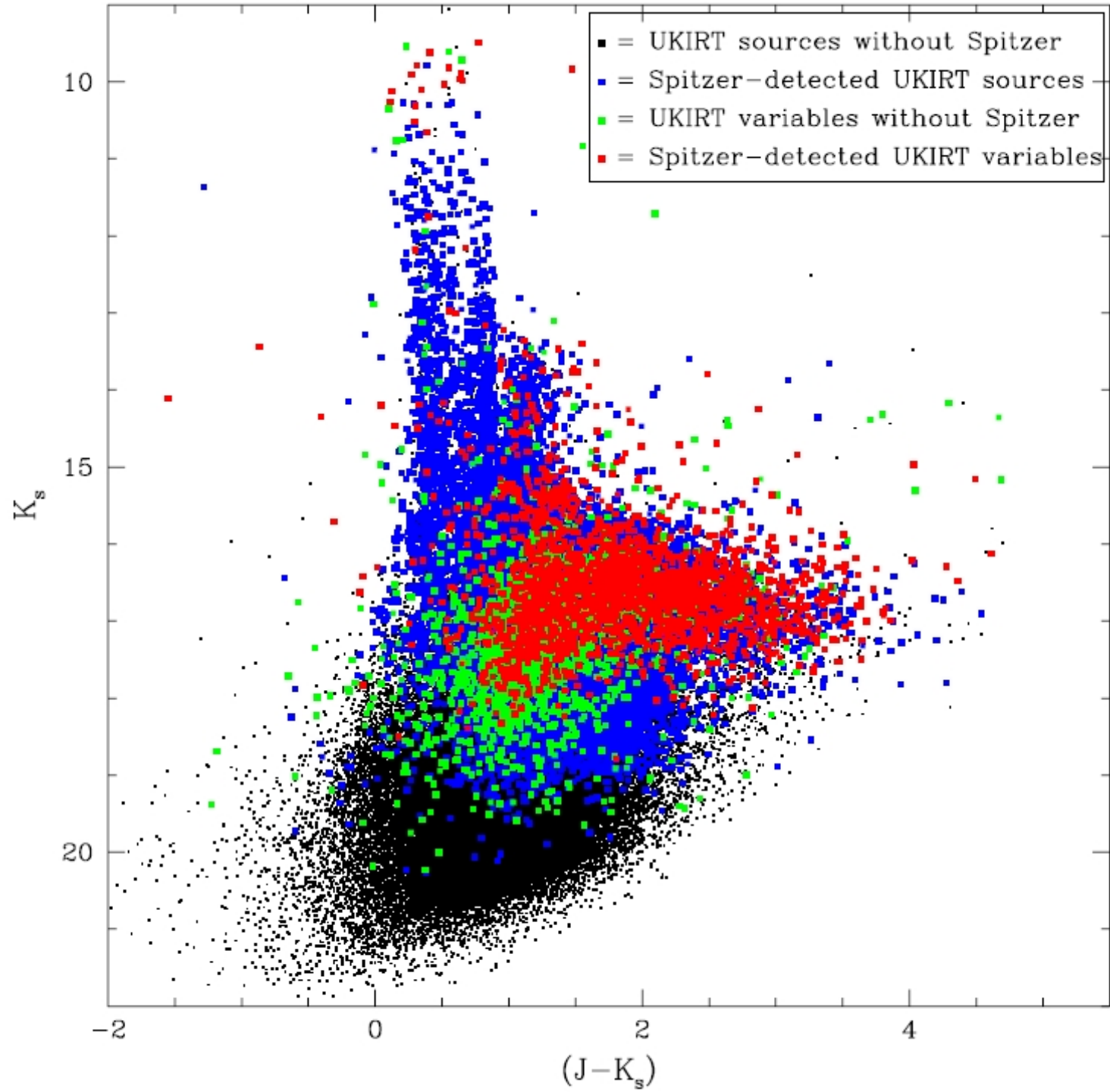






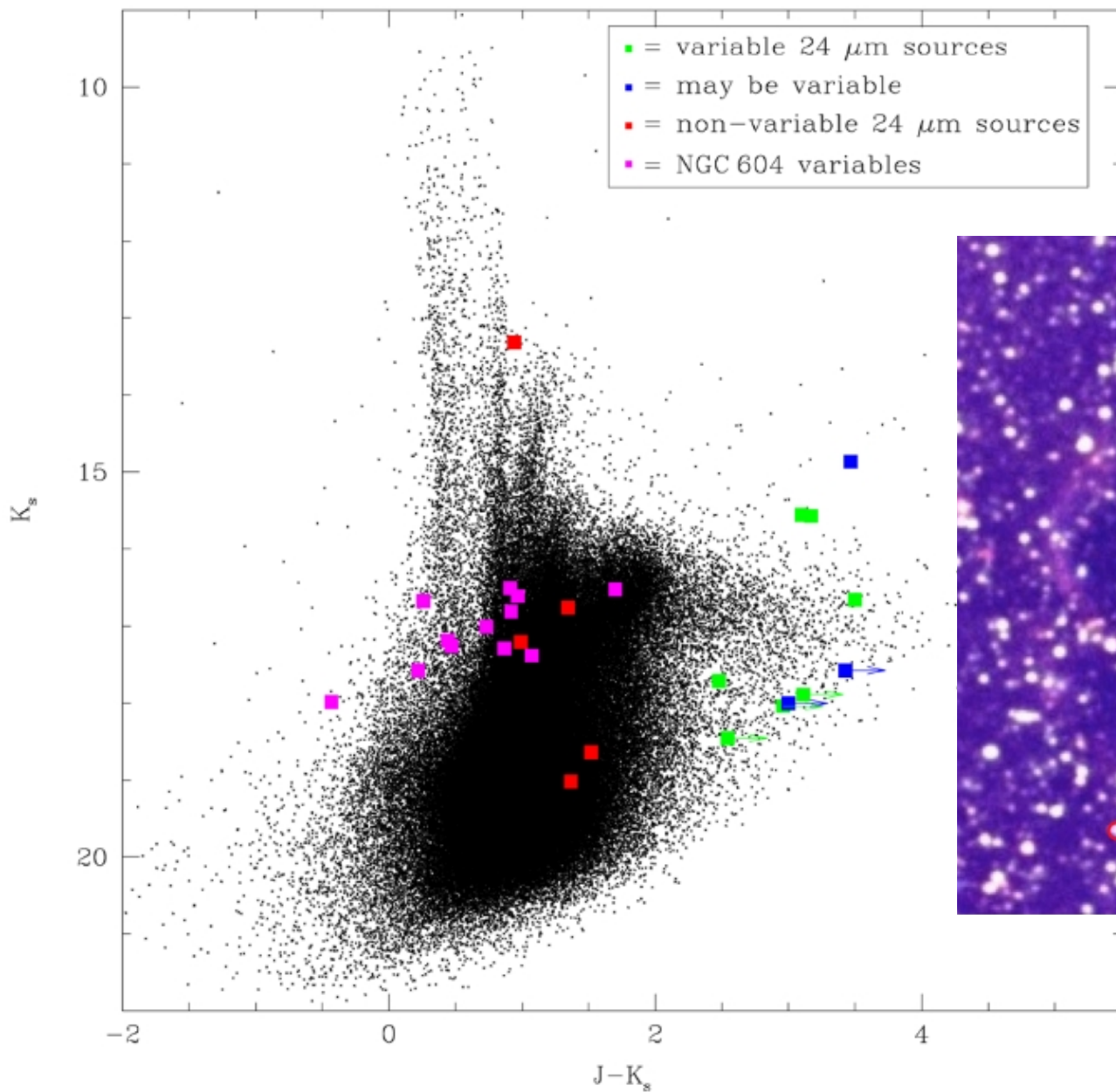
# Mass return (solar mass per year per square kpc)



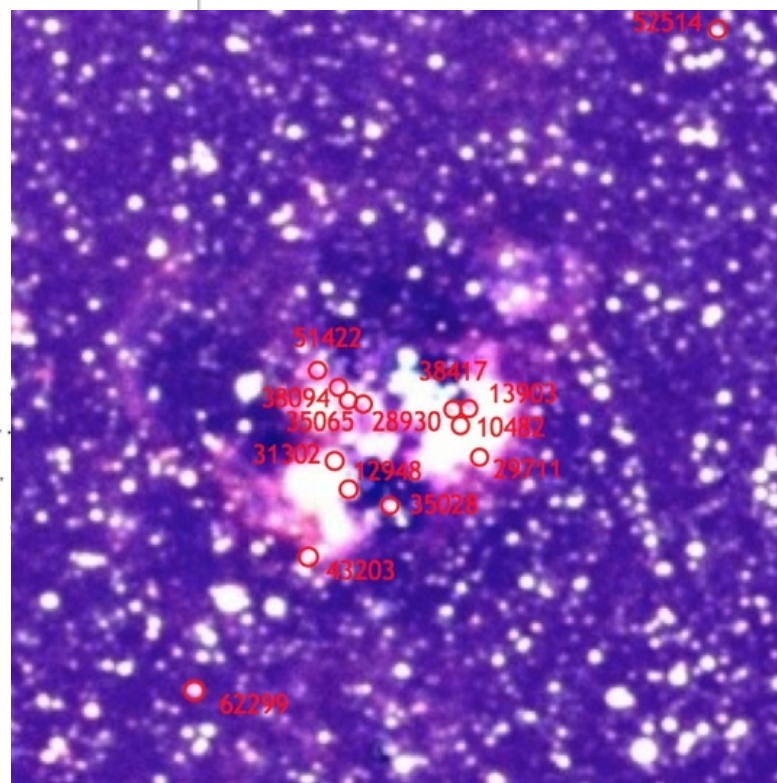




# comparison with 24-micron variables from Montiel et al. 2015

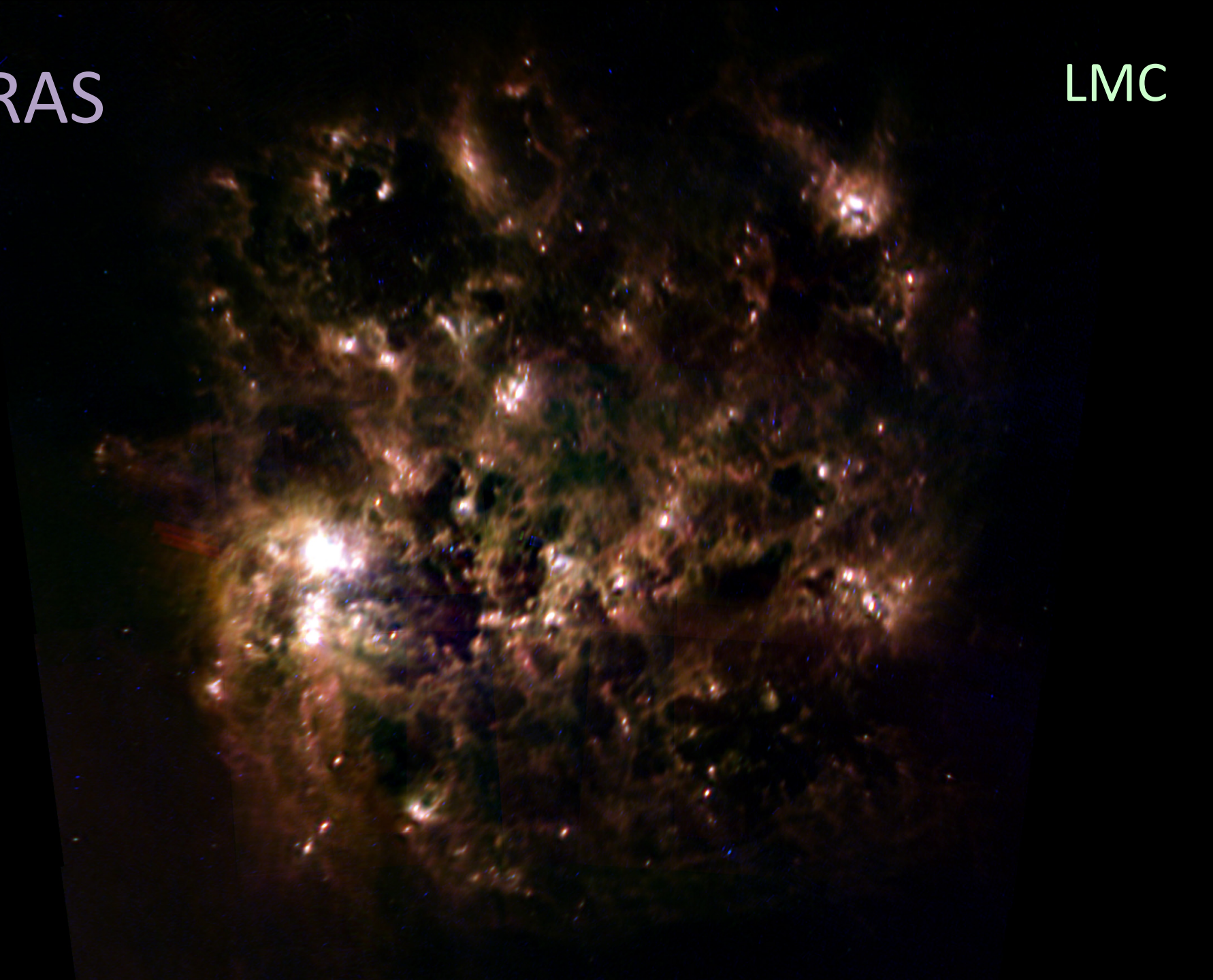


NGC 604



IRAS

LMC

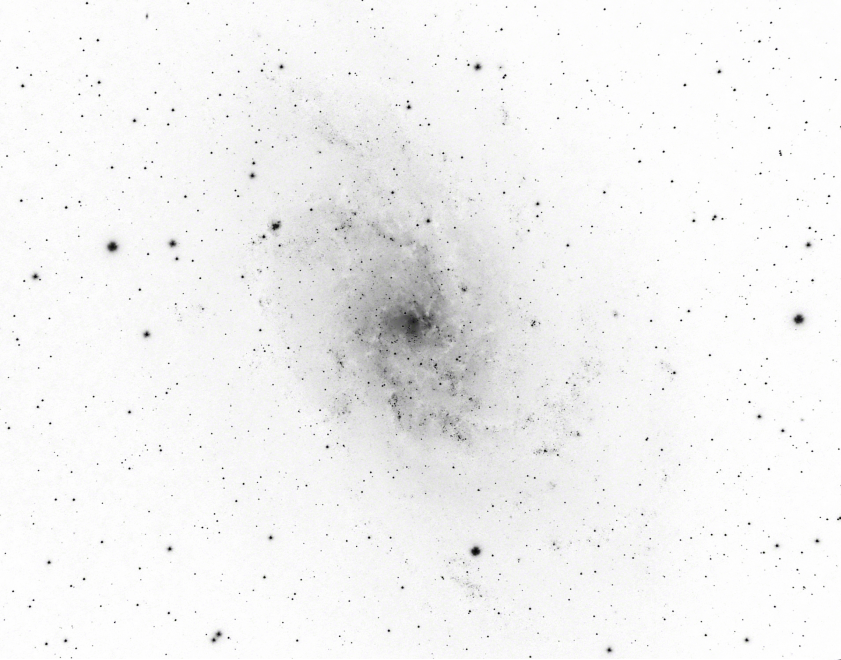


Spitzer

LMC



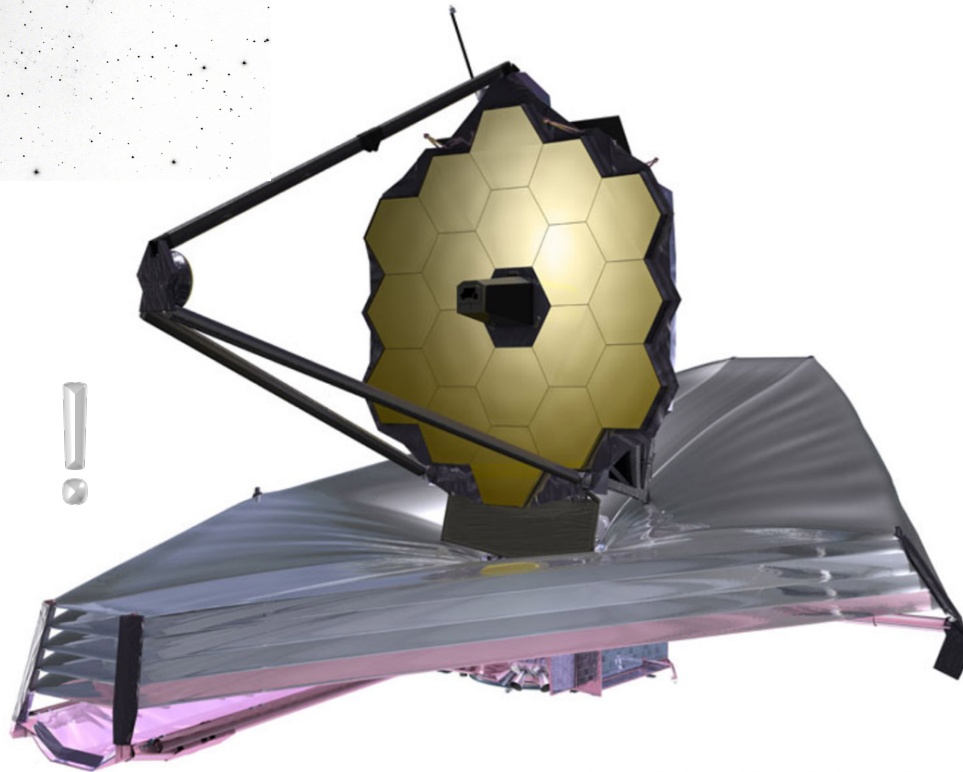
Meixner + 2006



interested in  
M33 (et cetera) with JWST/MIRI ?

[j.t.van.loon@keele.ac.uk](mailto:j.t.van.loon@keele.ac.uk)

Thanks !



The Leverhulme Trust



THE ROYAL  
SOCIETY

