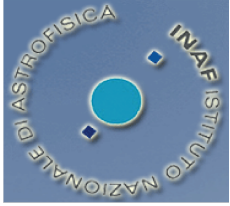




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The Gaia-ESO Survey: addressing extinction and reddening towards NGC6530

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OUTLINE

- **NGC6530** properties and issues
- **Reddening** across NGC6530:
 - cluster member selection
 - field star selection: giants and MS
 - intrinsic colors and reddening of all targets
 - reddening and spatial distribution
- **Reddening law $R=A_v/E(B-V)$** across NGC6530
 - Red Clump (RC) giant selection & photometric reddening law
 - Very reddened MS field star selection & spectroscopic reddening law
- **Conclusions and next steps**

NGC 6530

- **properties**

- a rich and young open cluster of few Myr old with several O type stars
- ~1250 pc from the Sun
- associated to the Lagoon Nebula-M8 a HII region of about 1.0 deg in diameter

- **issues**

- is the reddening uniform?
- is $R=A_v/E(B-V)$ standard?

Why reddening and reddening law?

Table 5. Cluster Parameters of NGC 6530 (Tothill+2008)

Survey ^a	$E(B - V)/\text{mag}$	R	Age/Myr	d.m./mag	Distance/kpc
Walker	0.33 – 0.37	—	3 ^b	10.7 – 11.5	1.4 – 2.0
VAJ	0.35	—	2 ^b	11.0 – 11.25	1.6 – 1.8
Kilambi	0.35 ± 0.01	3.0	1 – 3 ^b	10.7	1.4
SJ	0.35	—	> 2 ^b	11.3 ± 0.1	1.8 ± 0.1
CN	0.36 ± 0.09	—	—	11.4	1.9
MRV	0.17 ^c	4.6 ± 0.3	—	11.35 ± 0.08	1.86 ± 0.07
VdA	0.3	3.1	few × 10	—	1.8 ± 0.2
SCB	0.35	> 3 ^d	1.5, 5 ^e	11.25 ± 0.1	1.8 ± 0.1
KSSB	—	3.9 ± 0.05 ^f	—	—	—
Damiani	—	—	0.8, 4 ^e	—	—
PDMS	—	—	2, 5 ^e	10.5	1.3
ABMMR	0.34, 0.30 ^g	—	—	10.5	1.3
Mayne	0.33	—	1–2	10.50 ^{+0.10} _{-0.01}	1.26 ^{+0.06} _{-0.01}

^a References as for Table 3; ^b probably unreliable — see section 3.4.

^c foreground extinction only; ^d anomalous, non-uniform

^e median age and age spread, respectively

^f subtracting foreground reddening yields $R - E(B - V)$

^g foreground extinction towards Hourglass and mean extinction towards early-type stars, respectively

$$0.30 < E(B - V) < 0.37$$

$$3.0 < R < 4.6$$

DATA

- 1948 UVES and Giraffe spectra from FLAMES/Giraffe multi-fibre spectrometer at the ESO VLT/UT2 telescope within the **Gaia-ESO Survey (iDR4)**

and from the literature:

- WFI@2.2m ESO **BVI** photometry (Prisinzano+ 2005)
- ACIS-I Chandra **X-ray** obs. (Damiani+ 2004)
- 2MASS **JHK** photometry (Skrutskie+ 2006)
- IRAC/**Spitzer** photometry (Kumar+ 2010)
- **VPHAS+** **H α** photometry (Kalari+ 2015)

NGC6530 Members

INCLUSIVE criteria:

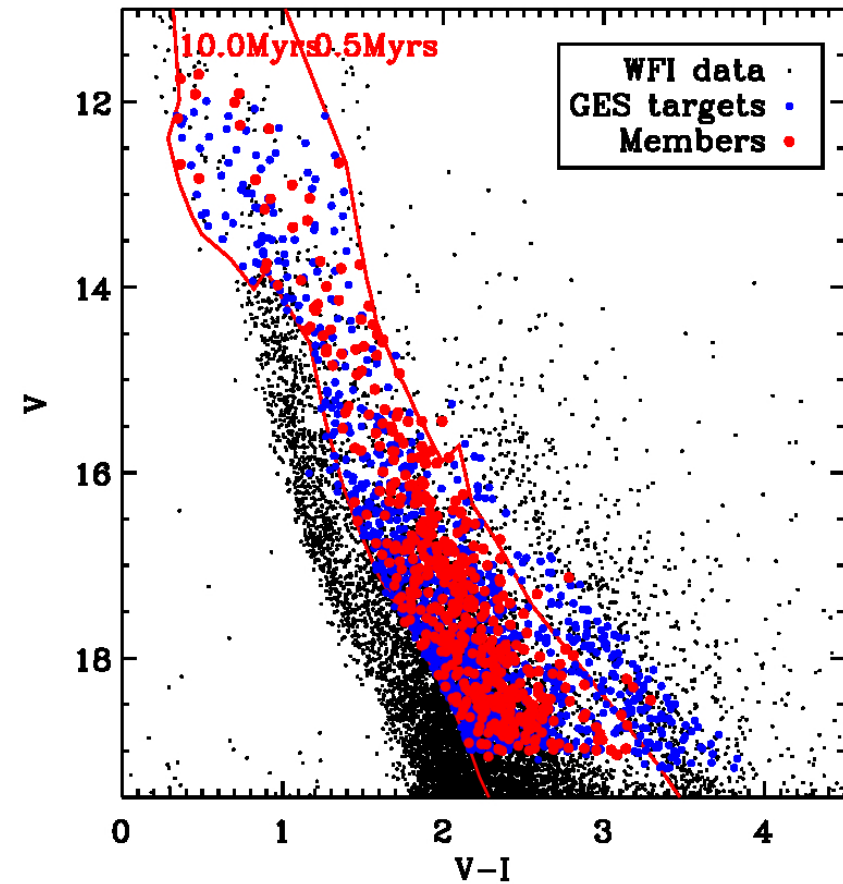
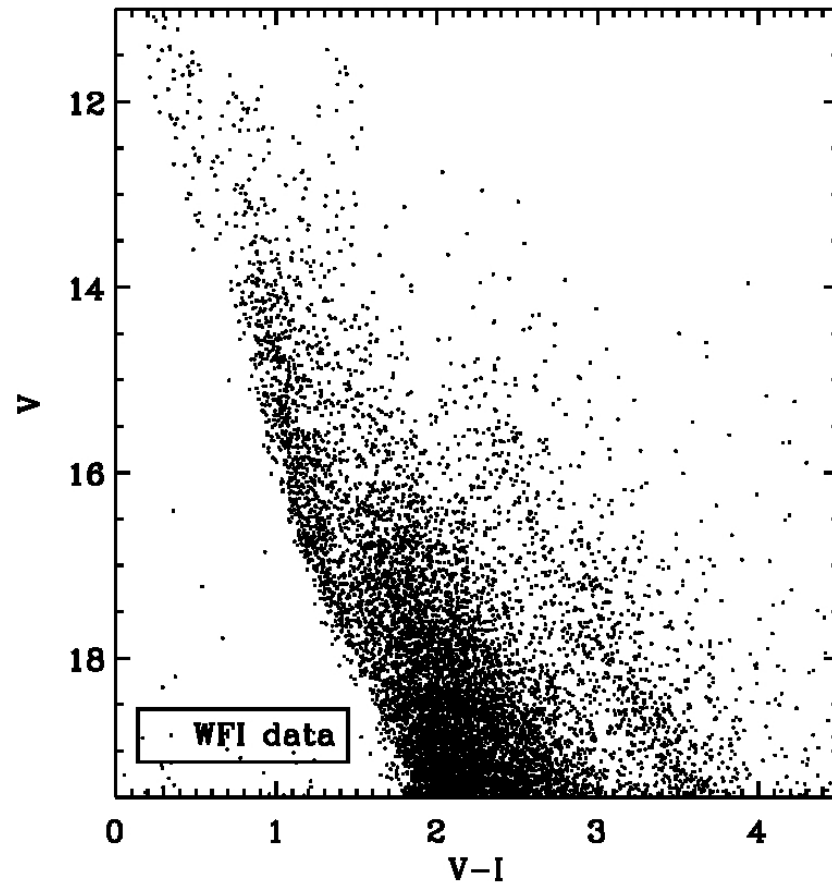
- **RV: $-15.5 < RV/[km/s] < 16.5$ i.e.** within 5σ from the cluster mean $\langle RV_{PDM07} \rangle = 0.5$ km/s and $\sigma_{PDM07} = 3.2$ km/s (Prisinzano +2007)
 - **Li: $EW(Li) > 90$ mÅ**
 - **Chandra/ACIS-I X-ray detections**
 - **Accretors: $FWZI(H\alpha) > 7\text{\AA}$**
 - **VPHAS+ $H\alpha$ accretors selected by Kalari+ 2015**
 - **JHK OR Spitzer/IRAC IR excesses**
- } **CTTS**

→ 522 members

with **AT LEAST 2** of the previous criteria fulfilled

281 are CTTS and 241 are WTTS

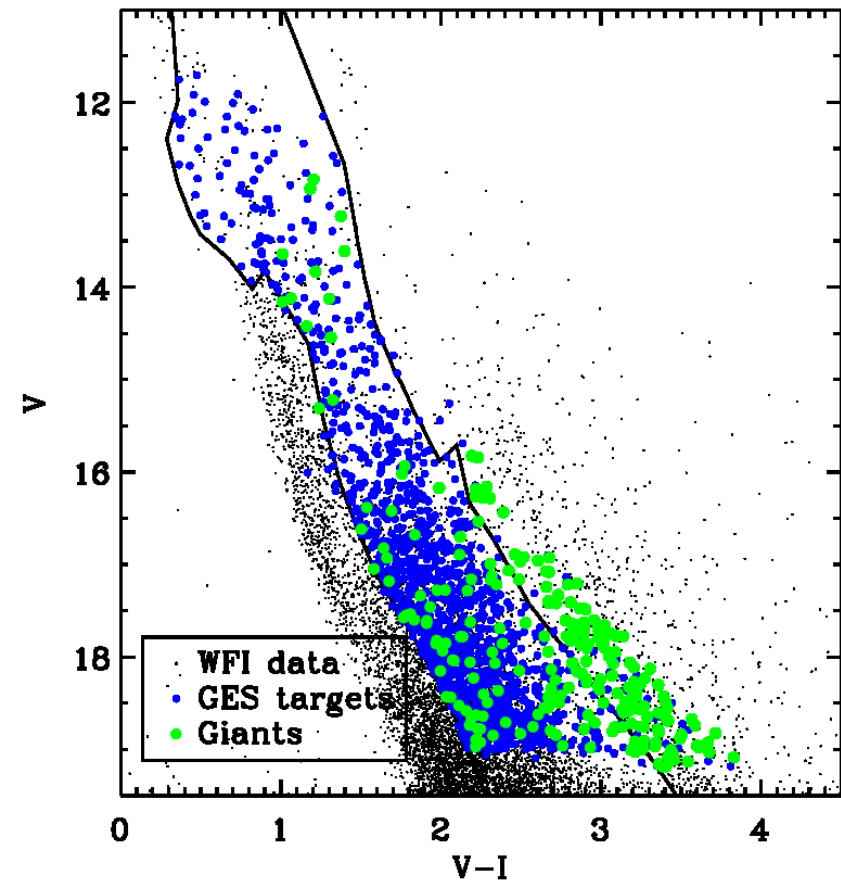
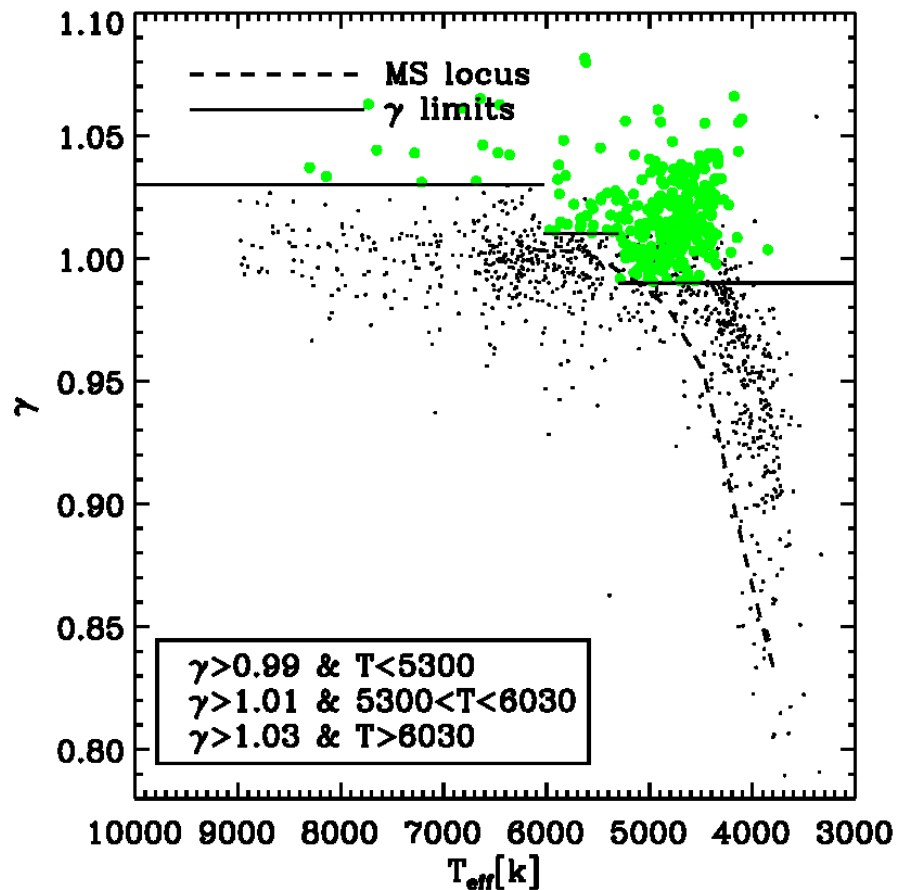
NGC6530 member selection



REDDENING LAW

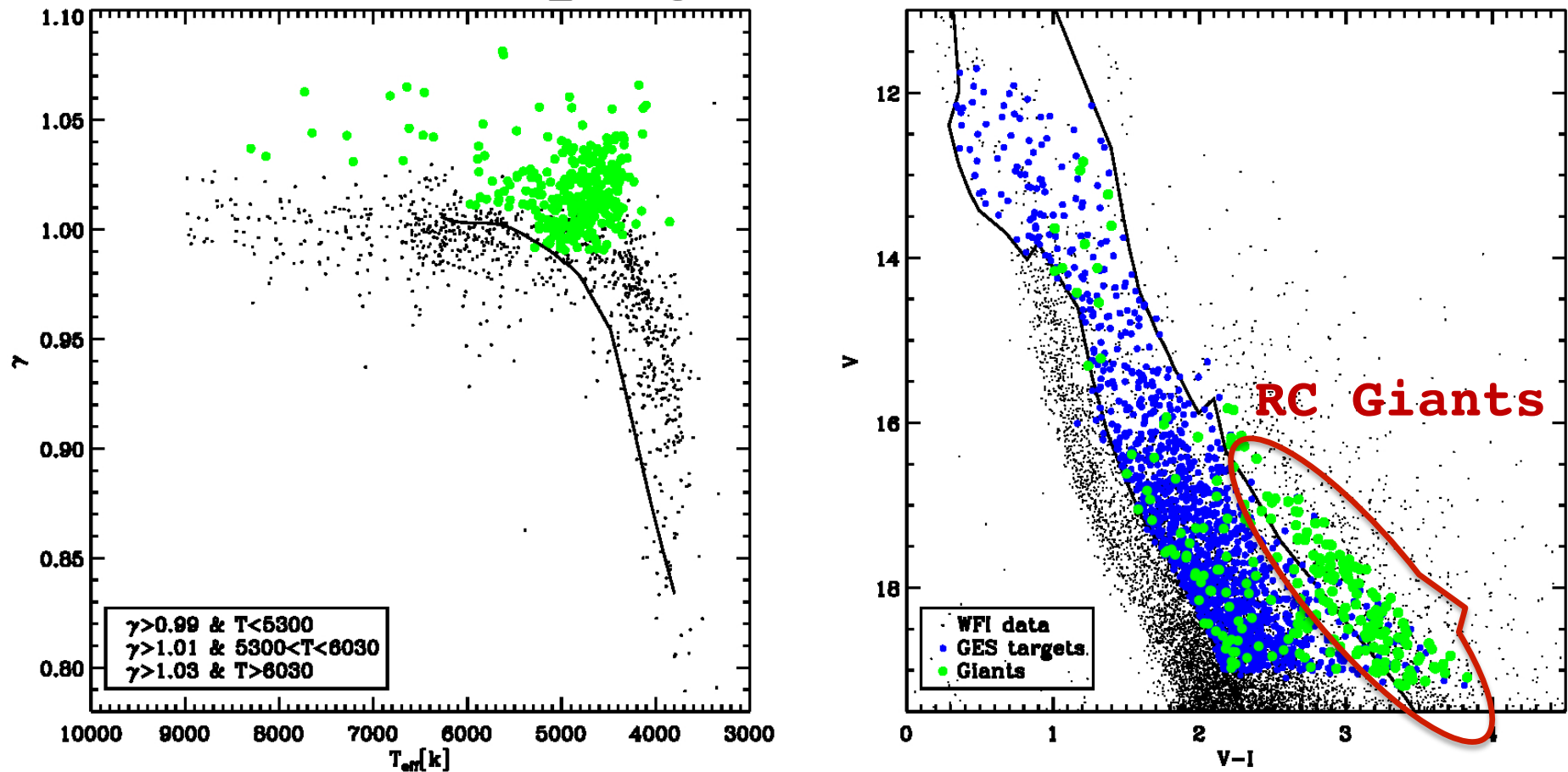
FIELD BACKGROUND GIANTS

by using the Gaia-ESO γ gravity index and T_{eff} (Damiani+14) among non-members

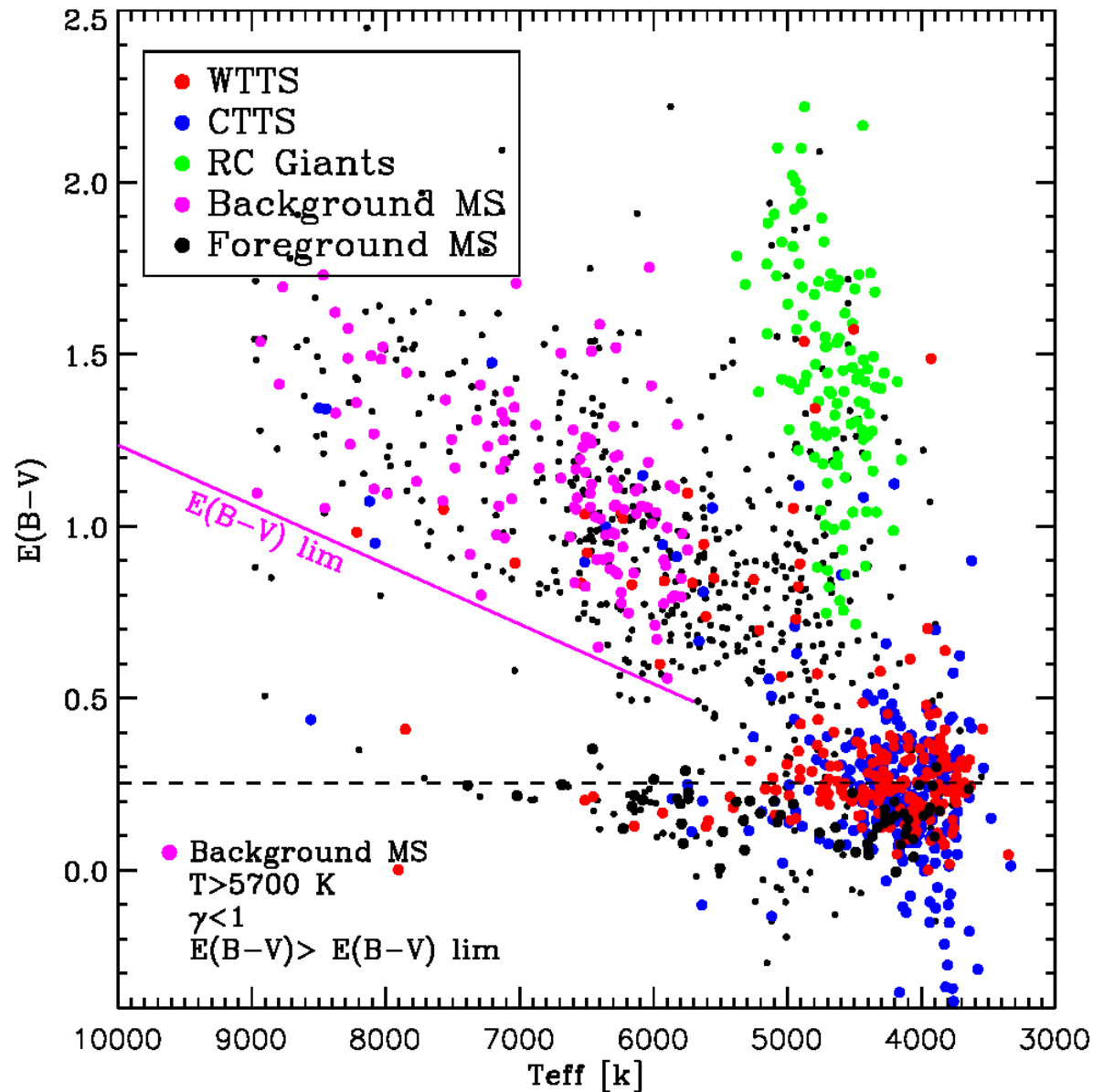


REDDENING LAW

Red Clump giant selection



Reddening from T_{eff} and B-V



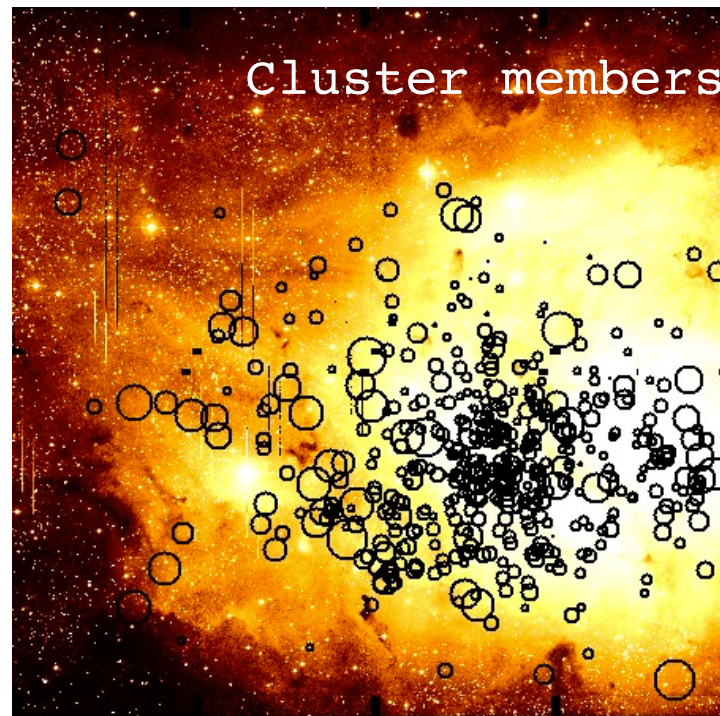
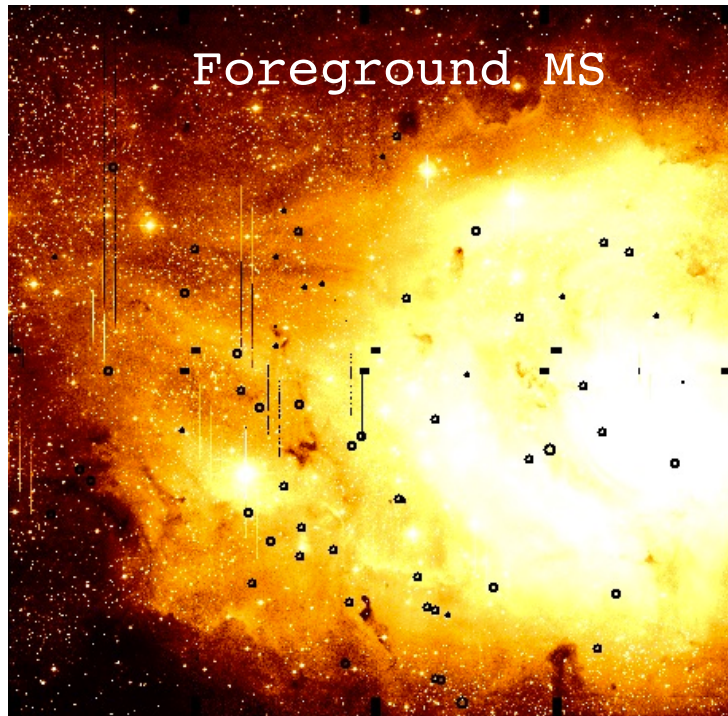
**color- T_{eff}
conversion:**

- MS and PMS:

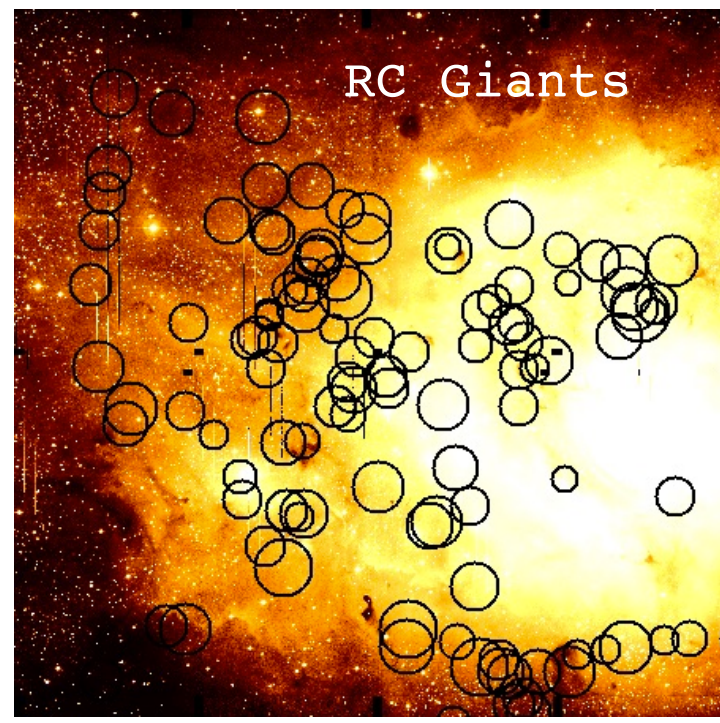
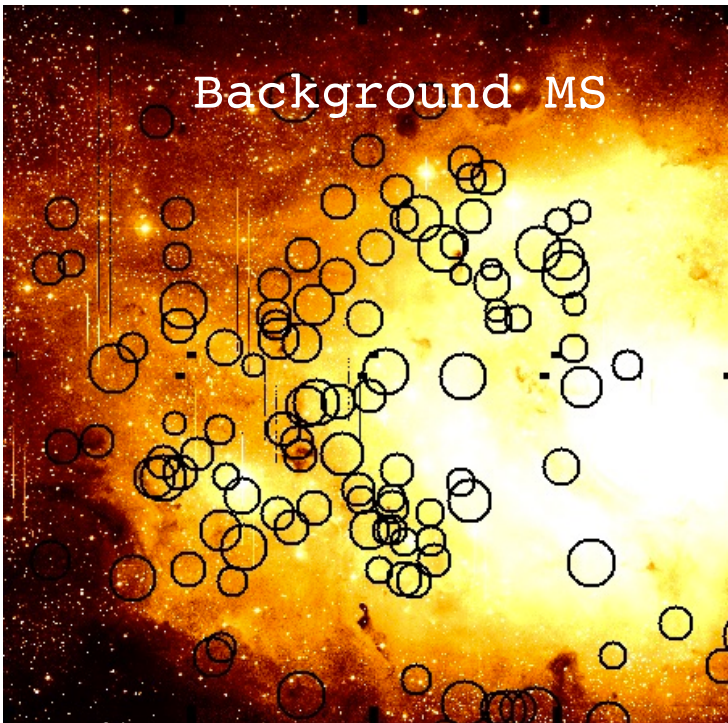
Kenyon & Hartmann 1995
and Stauffer+98

- Giants:

Bessel & Brett 1989



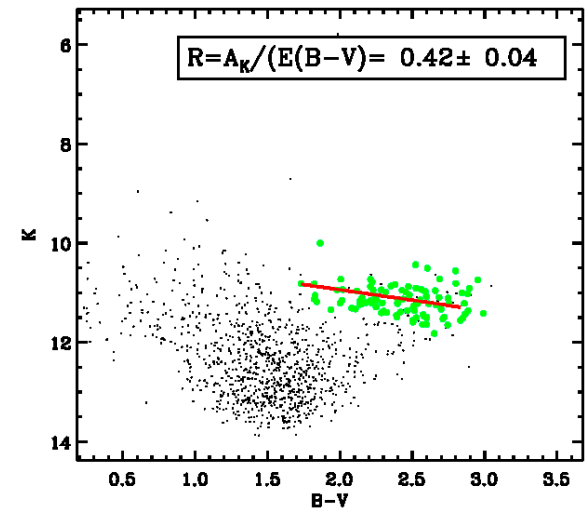
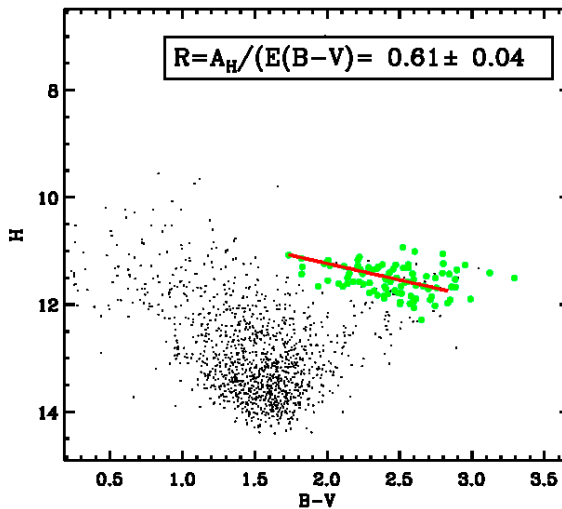
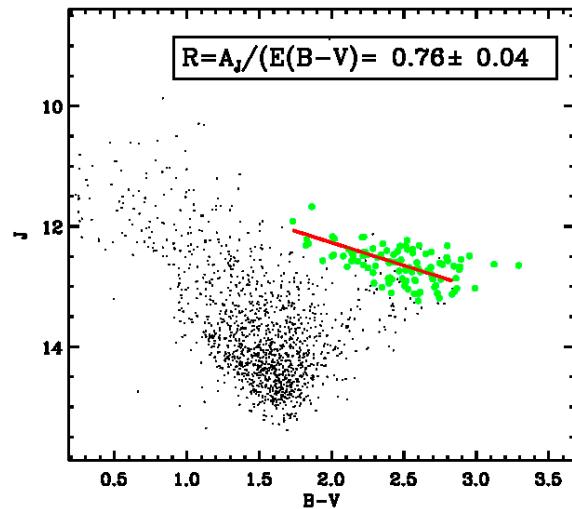
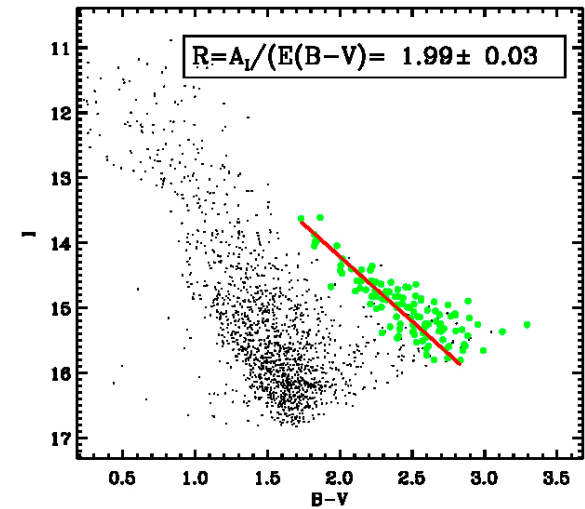
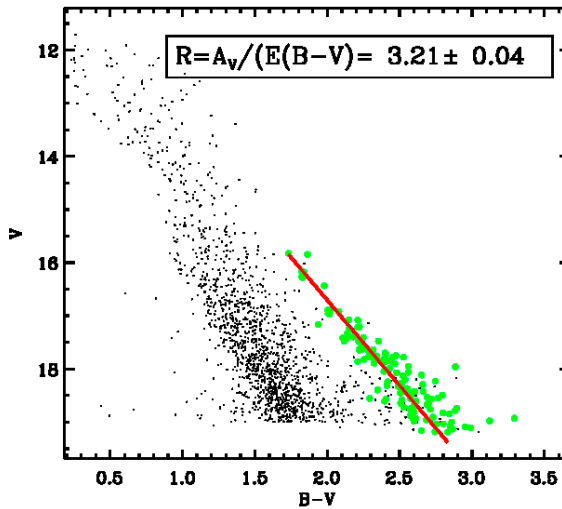
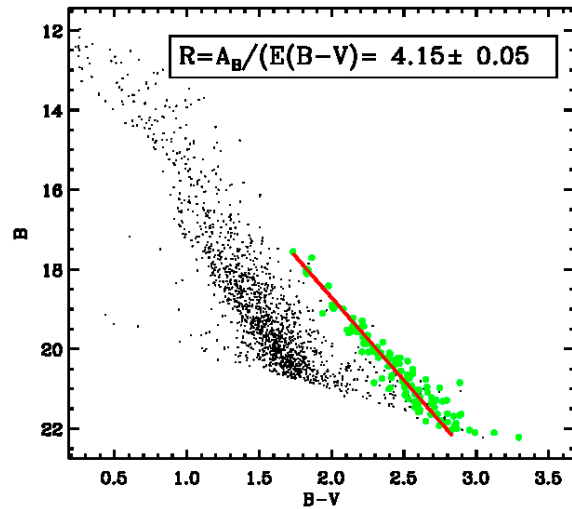
- Symbols proportional to $E(B-V)$
- Members & reddened background stars are spatially anticorrelated
- Toward East the least opaque region



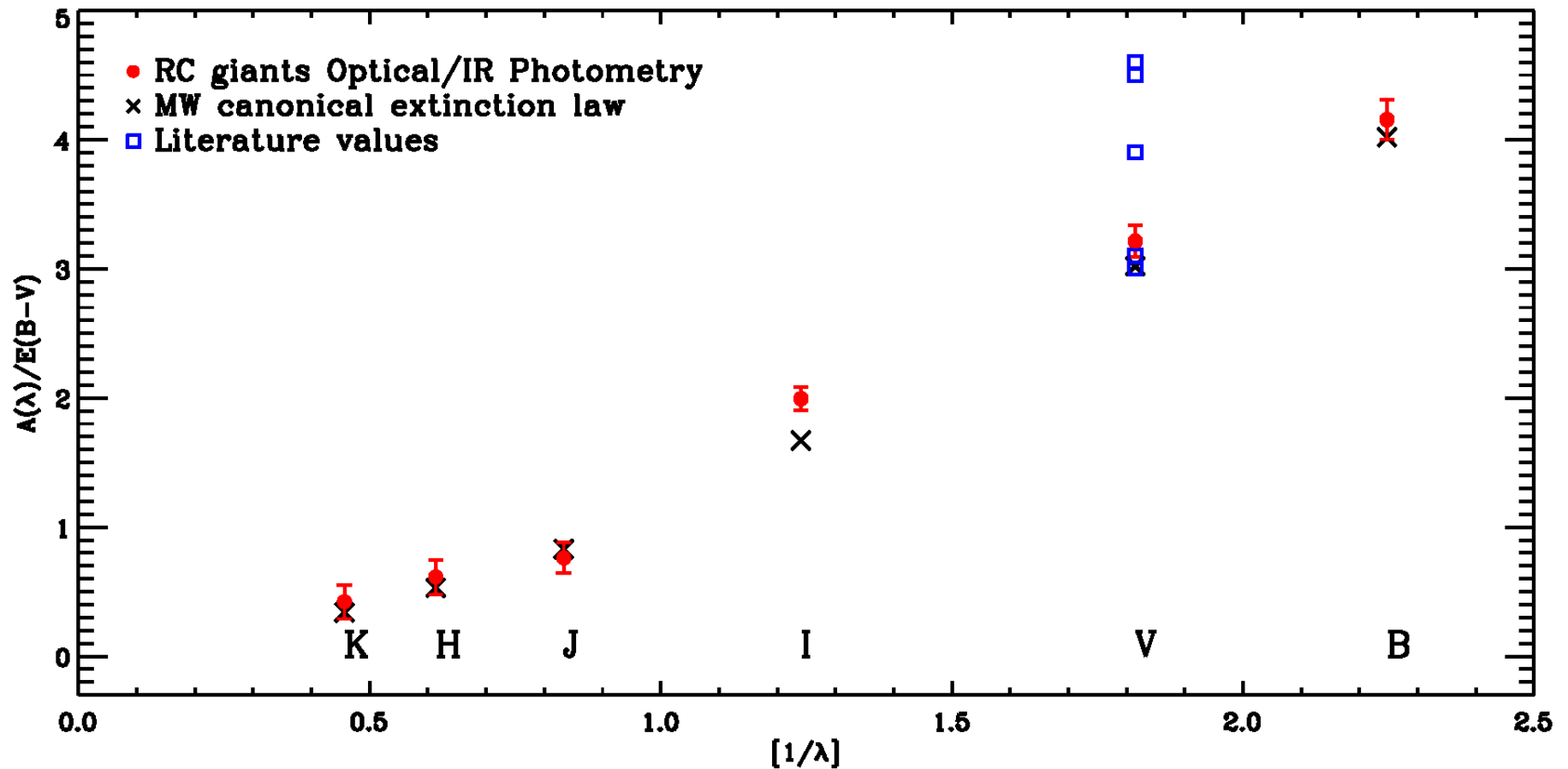
3D Nebula structure from REDDENING

PHOTOMETRIC REDDENING LAW

- RC giants: same distance, similar luminosities, T_{eff}
- observed slopes give R_{λ} (De Marchi+14)

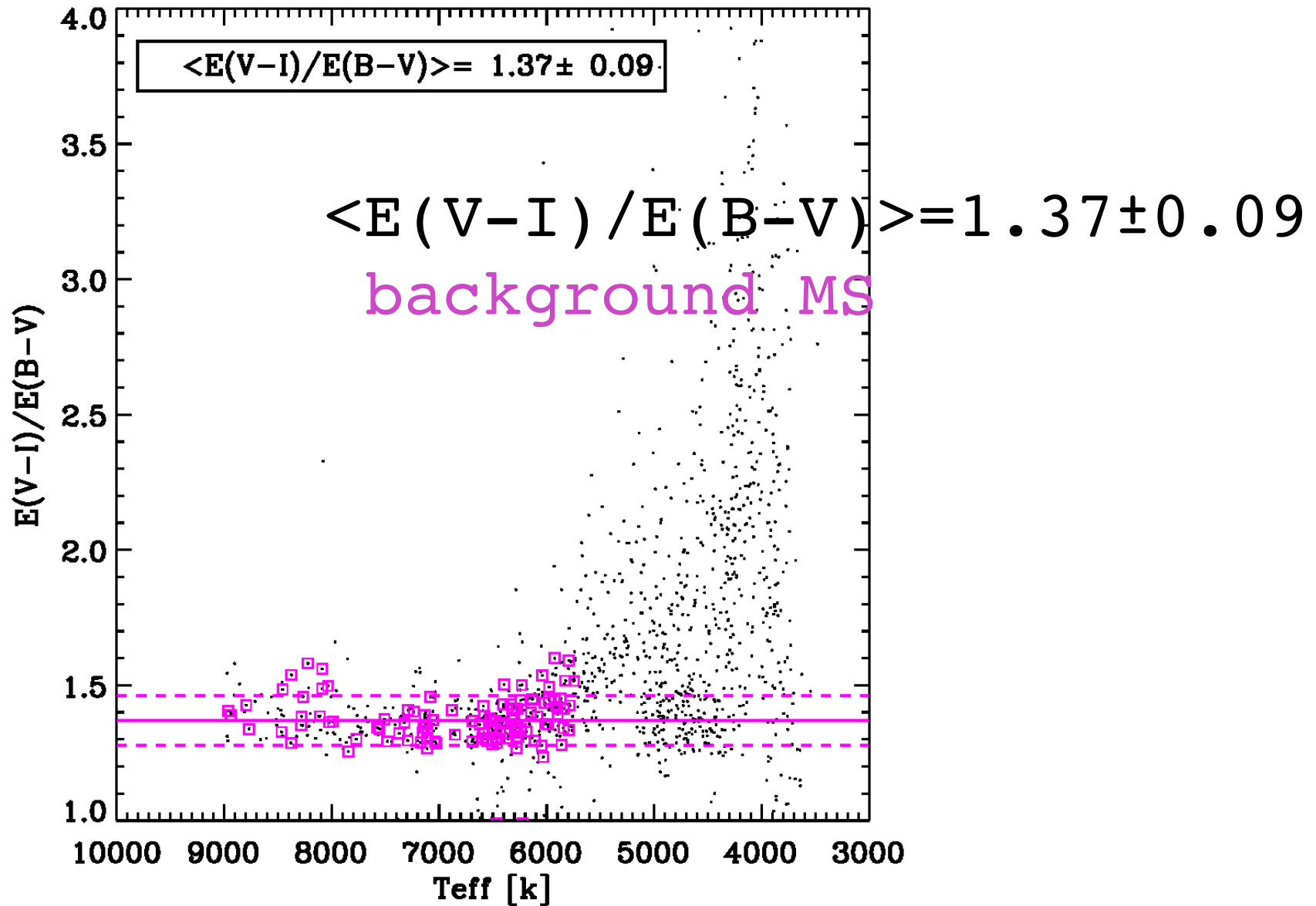


PHOTOMETRIC REDDENING LAW

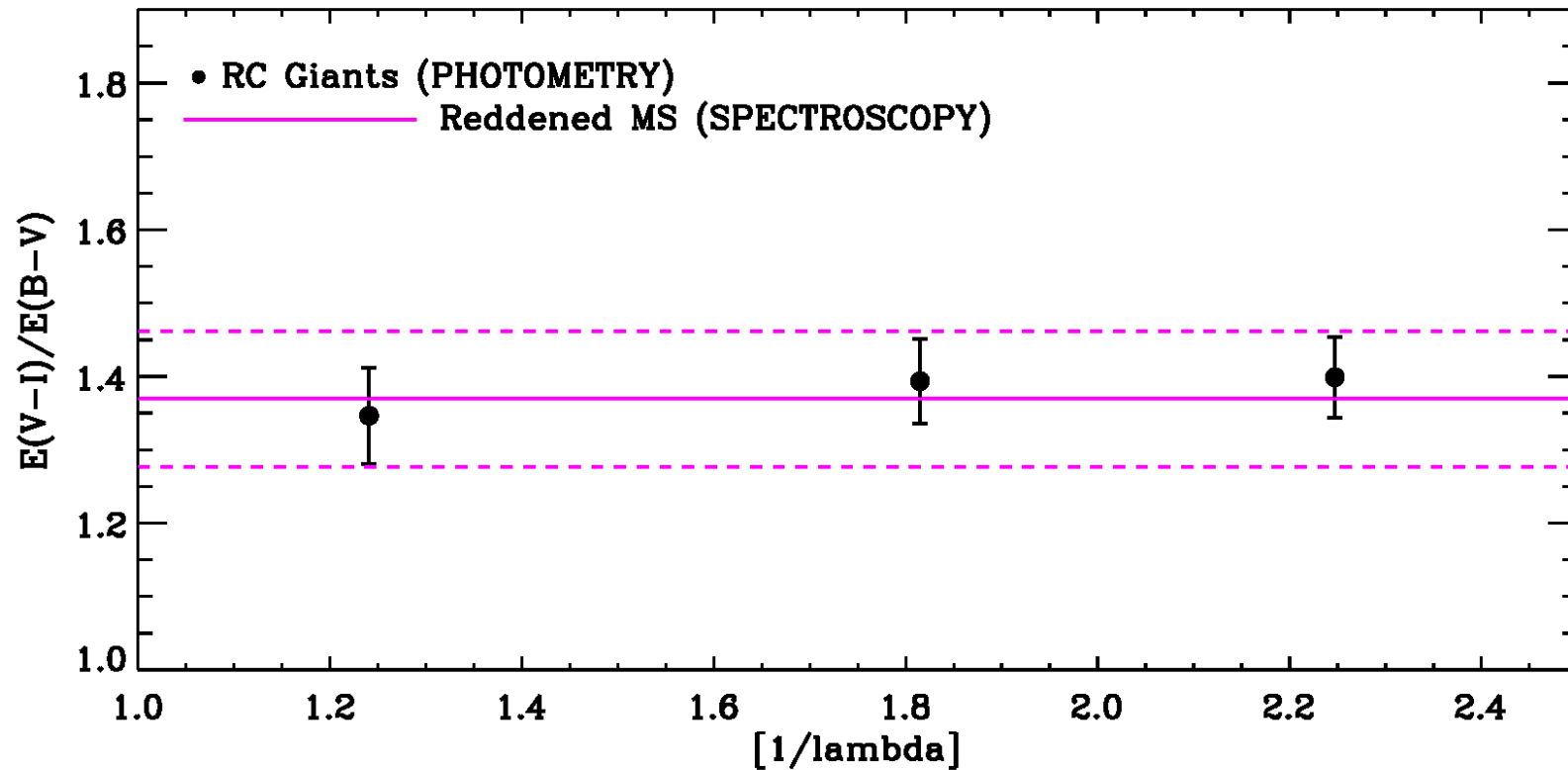


The reddening law in the region around NGC6530
is **standard!**

SPECTROSCOPIC REDDENING LAW



PHOTOMETRIC/SPECTROSCOPIC REDDENING LAW COMPARISON



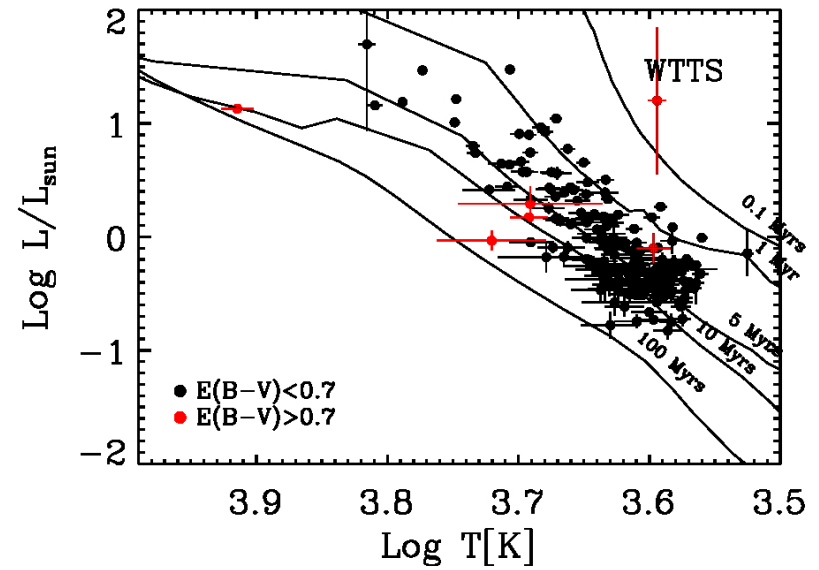
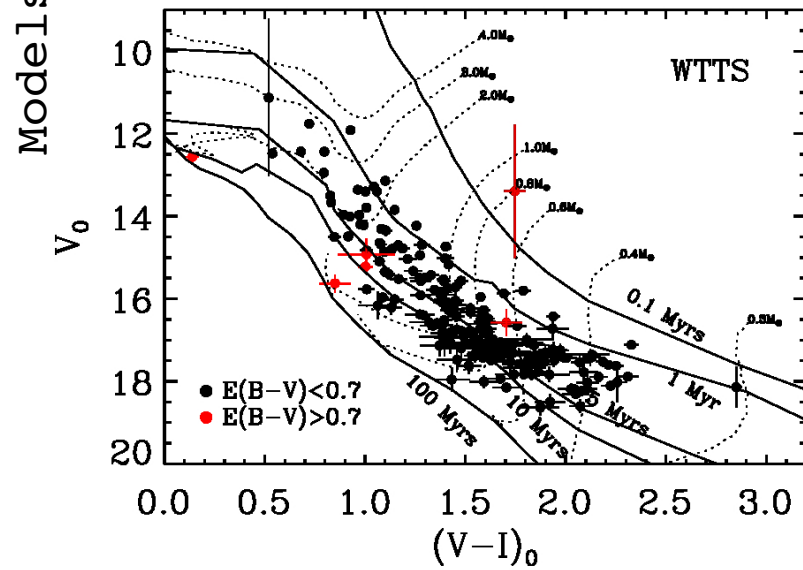
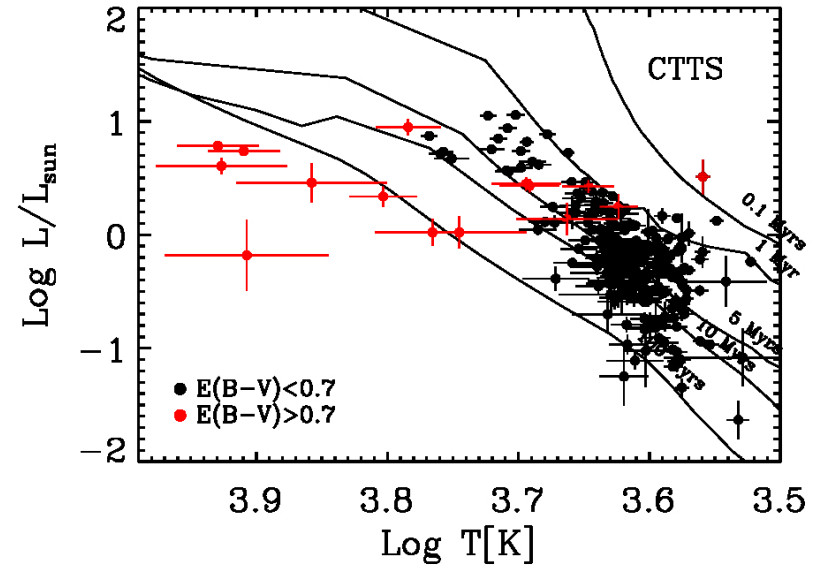
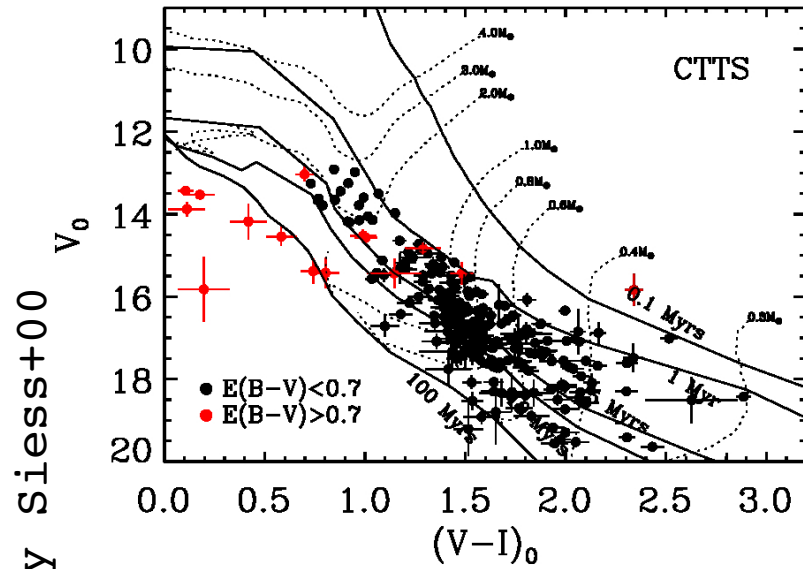
THE SPECTROSCOPIC ratio $E(V-I)/E(B-V)$ from reddened MS stars is in agreement with the ratio obtained photometrically by using RC giants

Summary and conclusions

- **522 members** of NGC6530 selected by using GES + literature data
- **Field background giants** selected from GES T_{eff} and γ (gravity index)
- **Foreground and background MS field stars** selected from $E(B-V)$
- **3D structure of the Nebula:**
 - most of cluster members have $E(B-V) < 0.5$
 - **the cluster is in front of the Nebula**
 - **the least opaque region is around the cluster** where very reddened background MS and giants are found!
 - behind the cluster very few background field stars
- **The reddening law AROUND the cluster is standard**

Next steps:

- is the reddening law standard also within the cluster?
- ages and age spread in NGC6530



-Both CTTS and WTTS cluster member ages are between 1 and 10 Myrs
 -Few very reddened members (mostly CTTS) lie outside the cluster region. These few objects deserve further investigations