Probing Galactic reddening with the 8620 Å DIB

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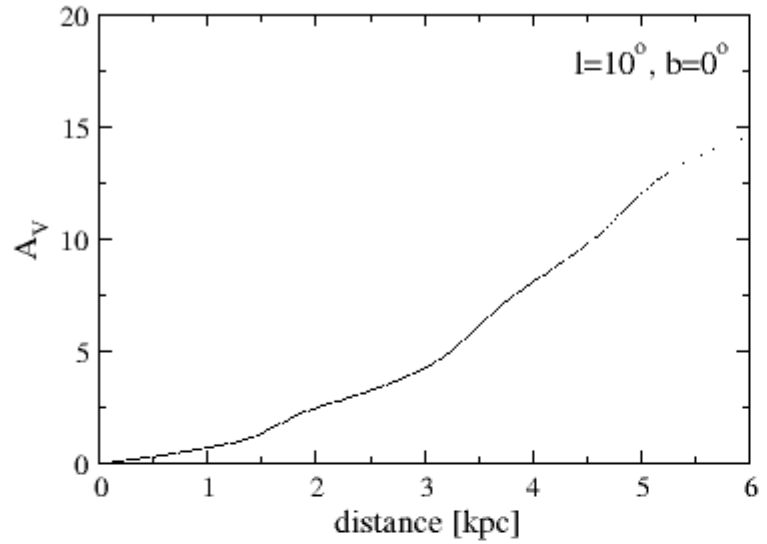
- For DIB 8620 Å reported good correlation between the equivalent width EW of the DIB and the interstellar reddening E_{B-V}, obtained from 37 stars distributed widely in galactic coordinates and distances (Munari 2000):

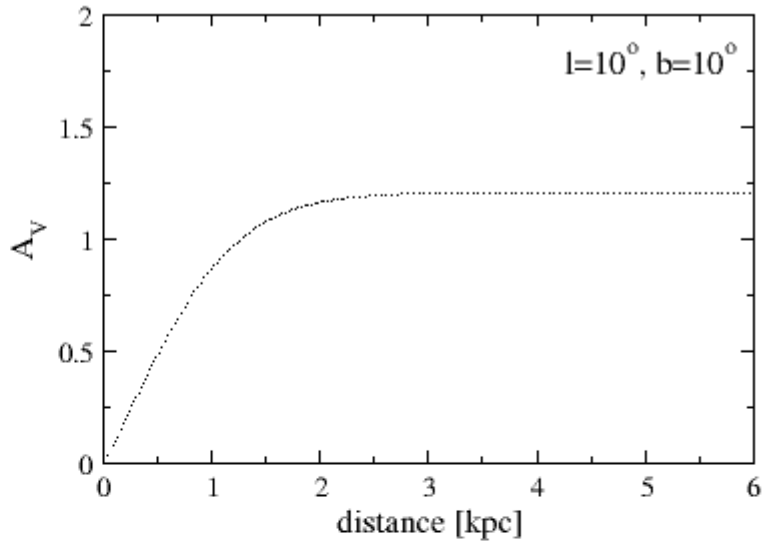
$$E_{B-V} = 2.69 \times EW\ (Å)$$

- In principal, the more general relation would be:

$$E_{B-V} = \alpha(l,b,d) \times EW\ (Å)$$

- *E_{B-V} will be determined by GAIA photometry. If DIB is resolved in the GAIA spectra:*
  - *Determination of α(l,b,d) → the distribution and composition of the interstellar matter...*
  - *Determination of the exact position of the DIB8620 → kinematics of the interstellar matter*


l=10°, b=0°
A_V
distance [kpc]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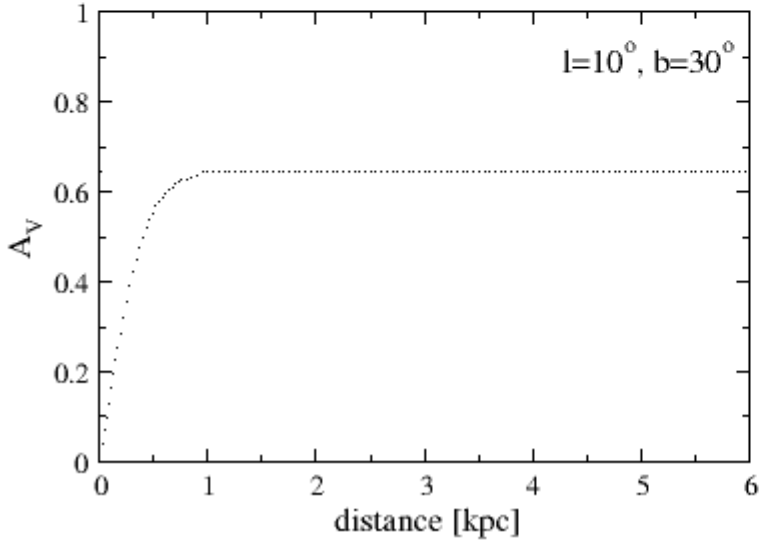
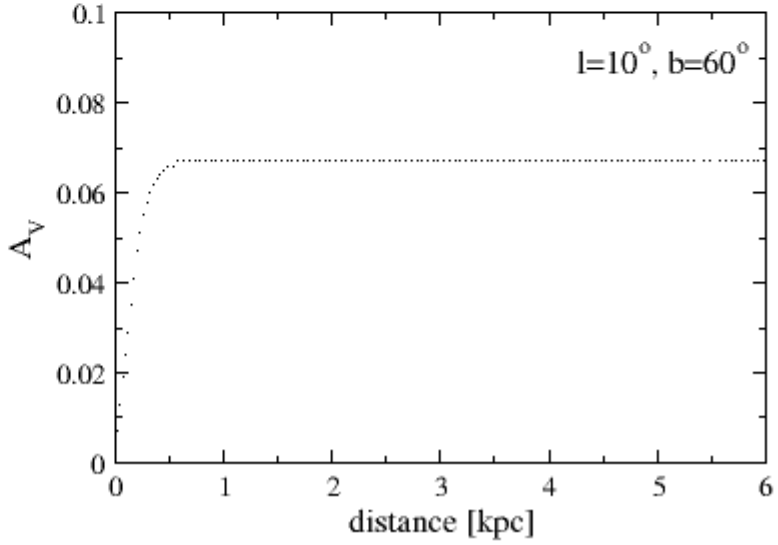
A_V
distance [kpc]


l=10°, b=30°
A_V
distance [kpc]


l=10°, b=60°
A_V
distance [kpc]

Simulation of the Galactic stellar population:

- Besançon model of stellar population synthesis
- Drimmel's Galactic extinction model

Simulations in specified galactic directions:

- 0.25 square degree solid angle
- simulated number of stars is more or less constant
- $l=10^o$, $b=0^o$, 10^o, 30^o

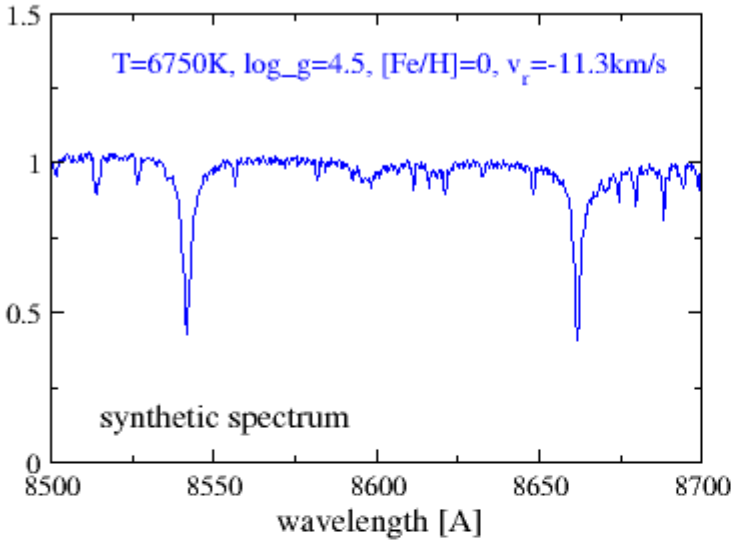
- For a given simulated star from the Besançon model:
  - simulating the RVS spectra with appropriate S/N
    - crowding
      - » not taken into account
    - mismatch
  - simulating the DIB8620 line
  - generating the appropriate synthetic spectral template

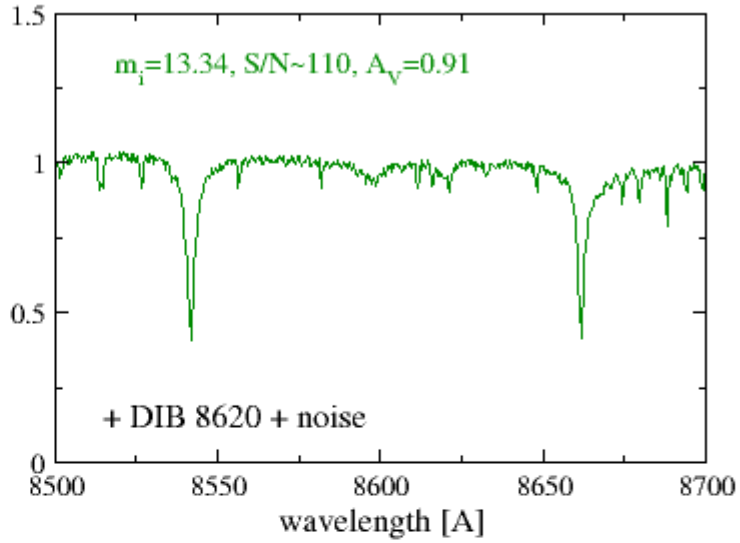
- simulating the RVS spectra:
  - the closest computed synthetic spectrum from the grid (Zwitter, Castelli, Munari 2004):
    - shifting for radial velocity
    - adding the DIB8620 line (Doppler shifted for between 0 and the shift for the star)
    - adding the noise, ~ appropriate to the star's magnitude (Munari et al. 2003):
  - adding the Gaussian $a \cdot e^{-\frac{(\lambda-\lambda_0)^2}{2\sigma^2}}$ for DIB8620
    - *E_{B-V} = 2.69 × EW (Å)*
    - *A_V=3.1 × 0.608 × (10000 / 8620 - 0.35) E_{B-V}*
    - *FWHM=5.5Å*

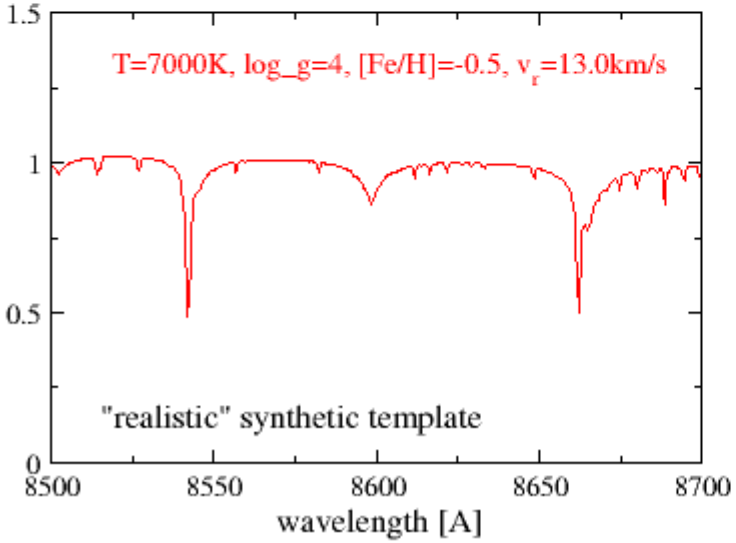
$$a = \frac{2EW}{FWHM} \times \sqrt{\frac{\ln 2}{\pi}} \qquad \sigma = \frac{FWHM}{\sqrt{8 \ln 2}}$$

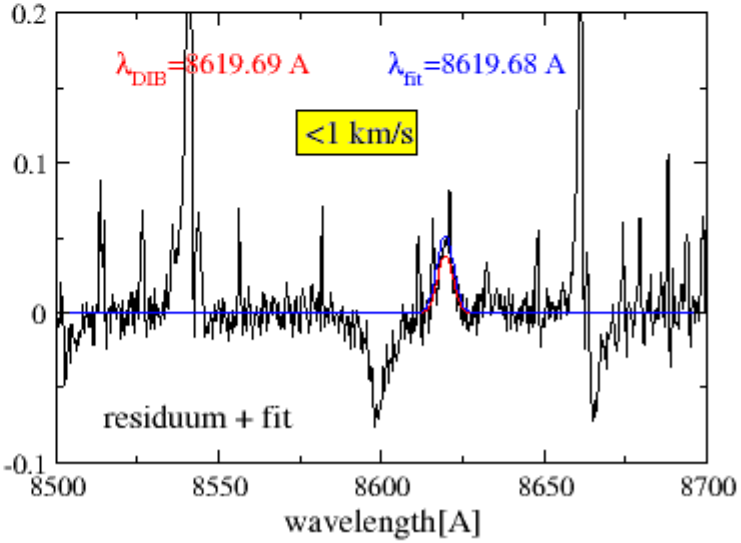
- generating the synthetic spectrum template:
  - differs from the “original” for one step in each parameter in the computed grid
  - differs from the “original” in the radial velocity (Katz et al. 2004)

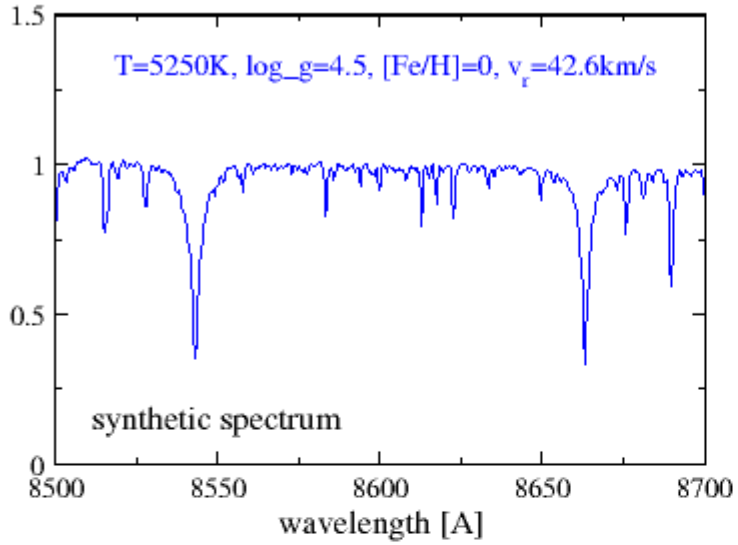
- substraction of the template from the RVS spectrum:
  - trying to resolve the DIB line on the residuum
  - fitting of a Gaussian with 3 parameters: a, σ, λ_0

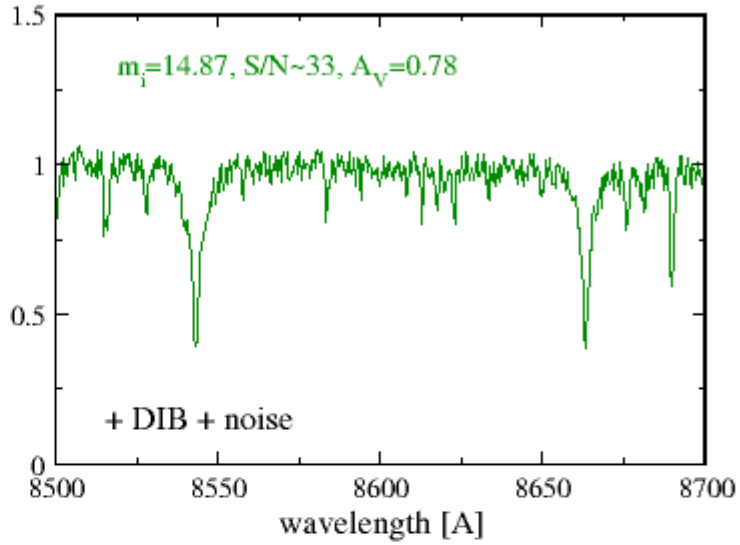

T=6750K, log_g=4.5, [Fe/H]=0, v_r=-11.3km/s
synthetic spectrum
wavelength [A]

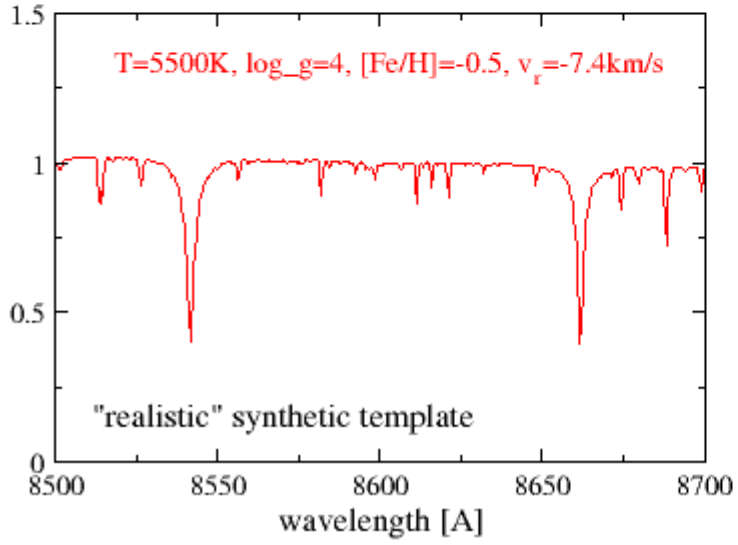

m_i=13.34, S/N~110, A_V=0.91
+ DIB 8620 + noise
wavelength [A]

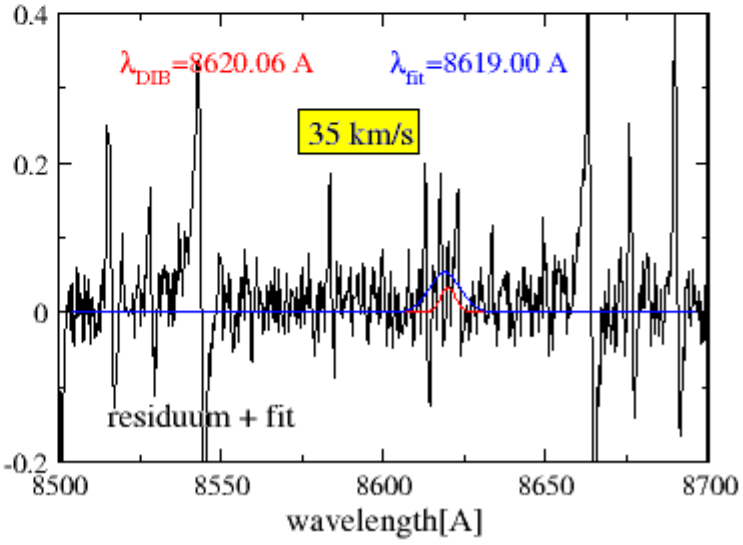

T=7000K, log_g=4, [Fe/H]=-0.5, v_r=13.0km/s
"realistic" synthetic template
wavelength [A]


λ_DIB=8619.69 A
λ_fit=8619.68 A
<1 km/s
residuum + fit
wavelength[A]

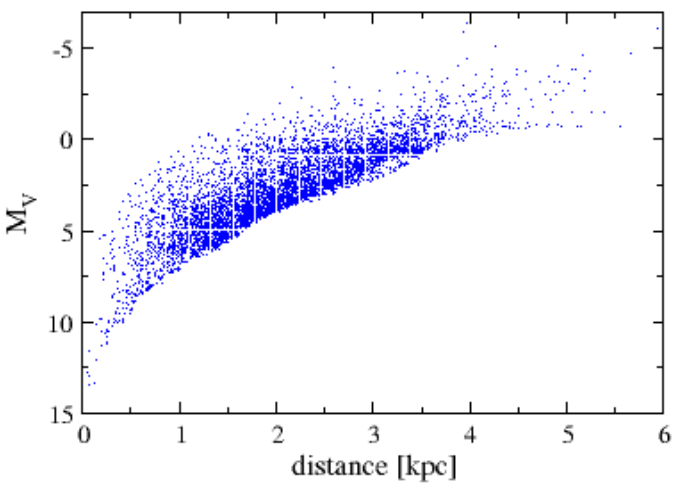

T=5250K, log_g=4.5, [Fe/H]=0, v_r=42.6km/s
synthetic spectrum
wavelength [A]

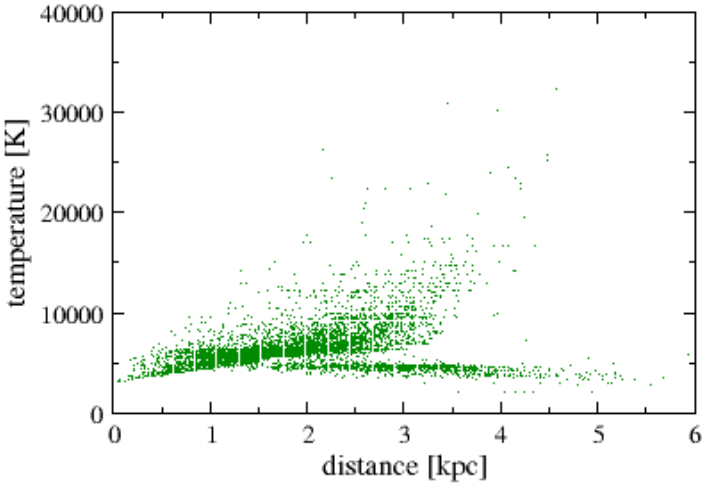

m_i=14.87, S/N~33, A_V=0.78
+ DIB + noise
wavelength [A]

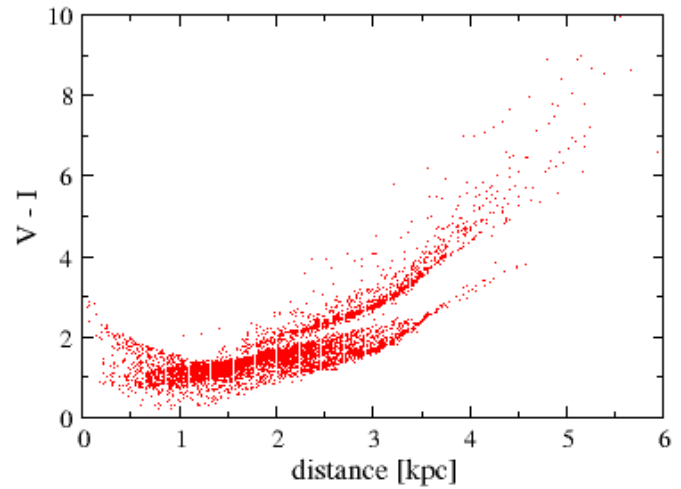

T=5500K, log_g=4, [Fe/H]=-0.5, v_r=-7.4km/s
"realistic" synthetic template
wavelength [A]

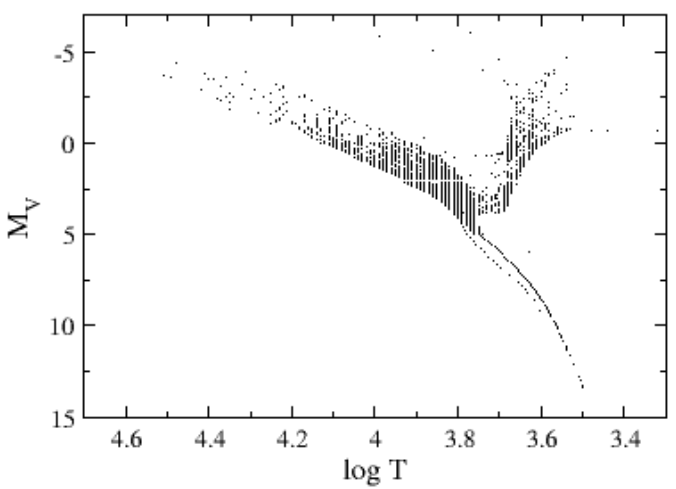

λ_DIB=8620.06 A
λ_fit=8619.00 A
35 km/s
residuum + fit
wavelength[A]

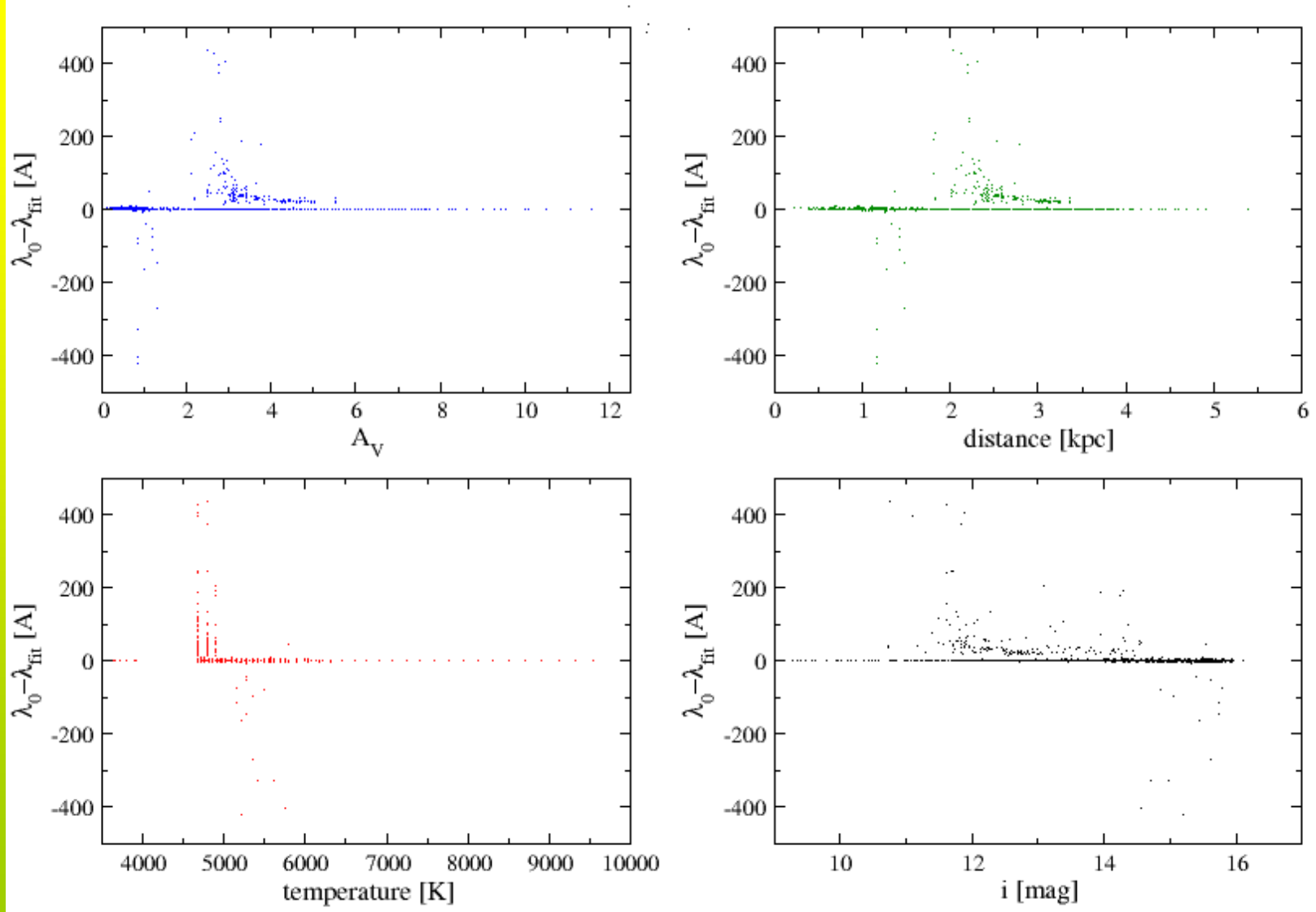
l=10º, b=0º, 2954/5262 stars

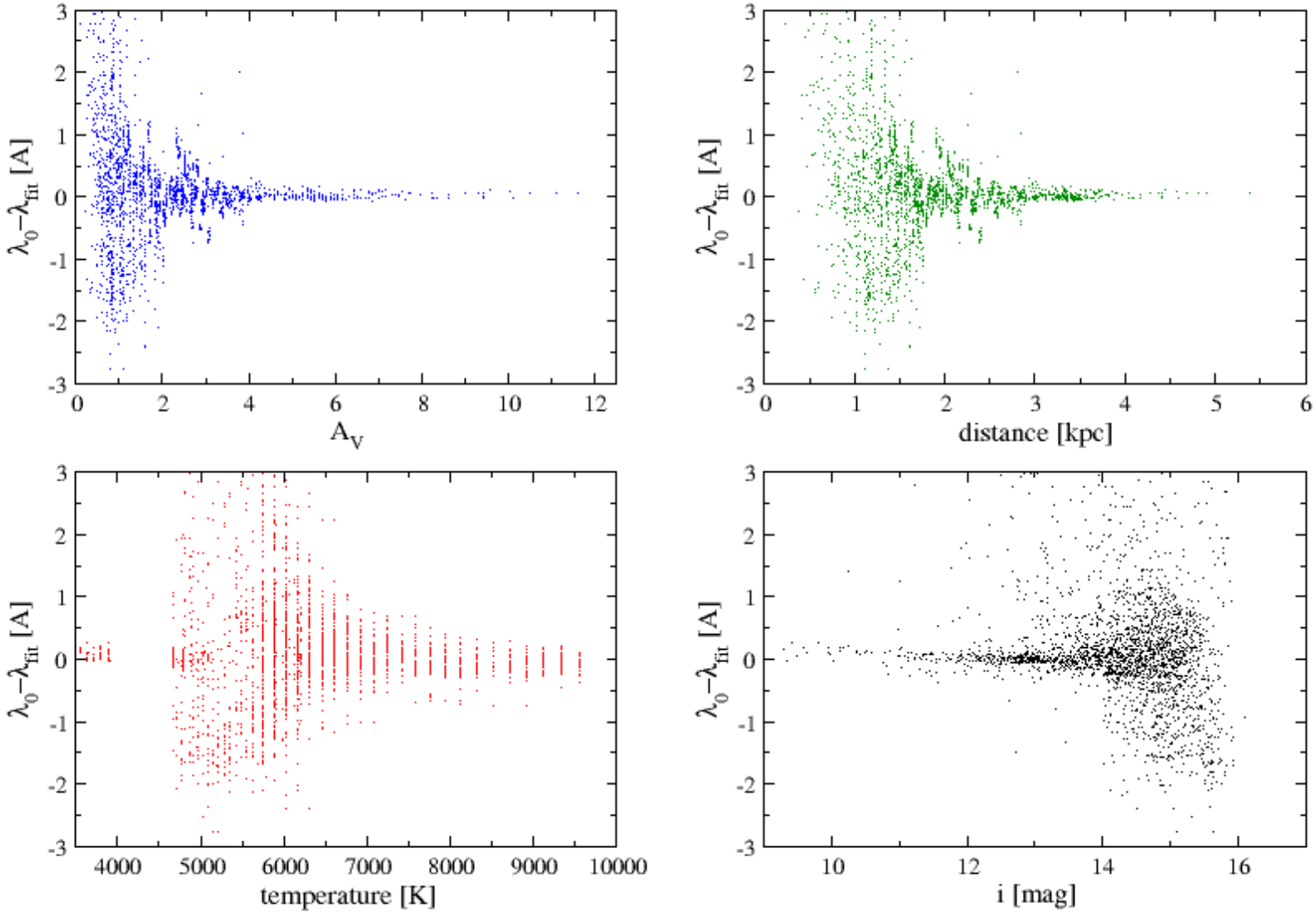






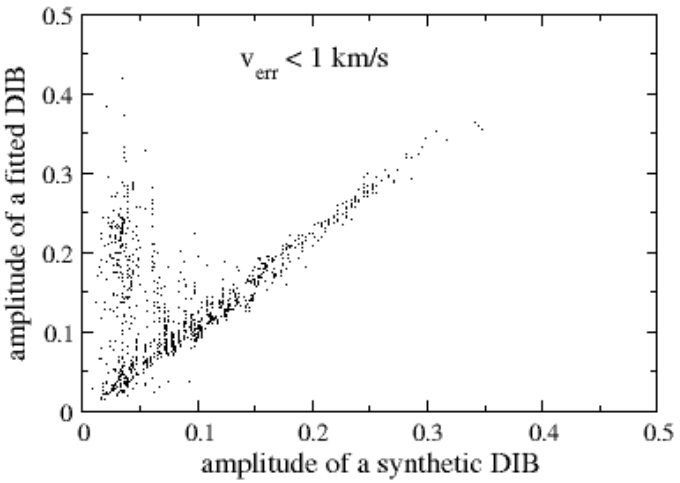


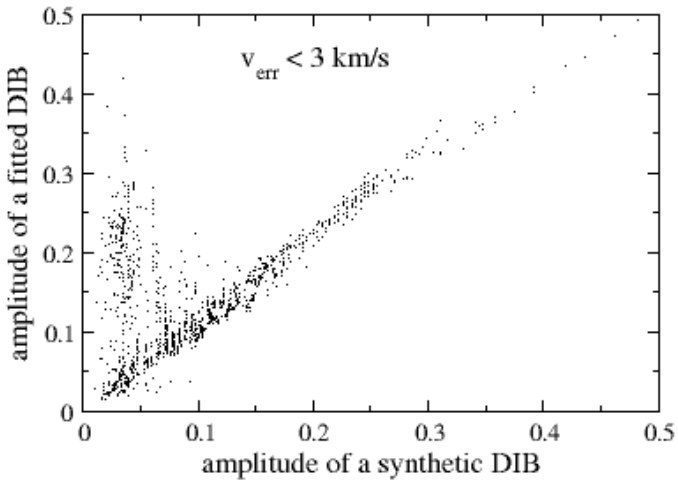

$\lambda_0-\lambda_{fit}$ [A]
400
200
0
-200
-400
0
2
4
6
8
10
12
A_V
$\lambda_0-\lambda_{fit}$ [A]
400
200
0
-200
-400
0
1
2
3
4
5
6
distance [kpc]
$\lambda_0-\lambda_{fit}$ [A]
400
200
0
-200
-400
4000
5000
6000
7000
8000
9000
10000
temperature [K]
$\lambda_0-\lambda_{fit}$ [A]
400
200
0
-200
-400
10
12
14
16
i [mag]

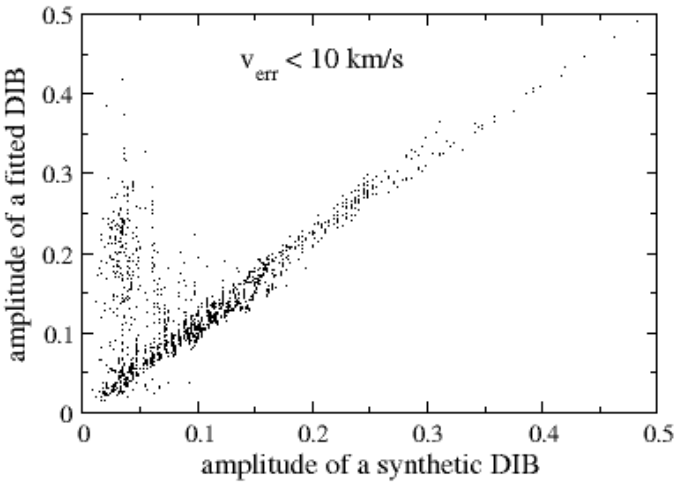

λ0−λfit [A]
AV
distance [kpc]
temperature [K]
i [mag]

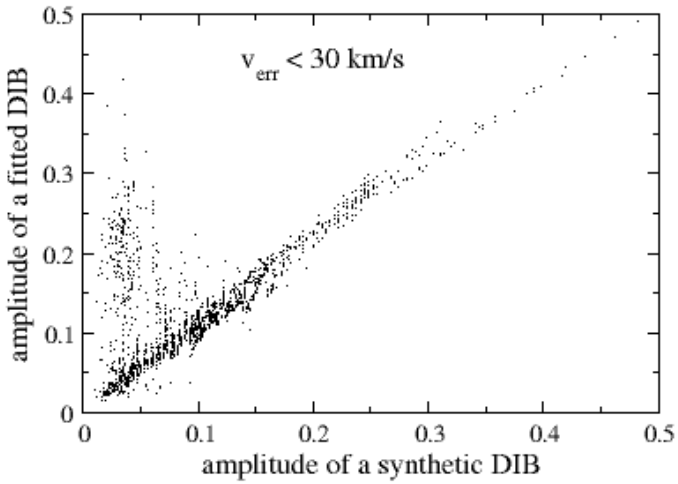
1391 stars

1558 stars





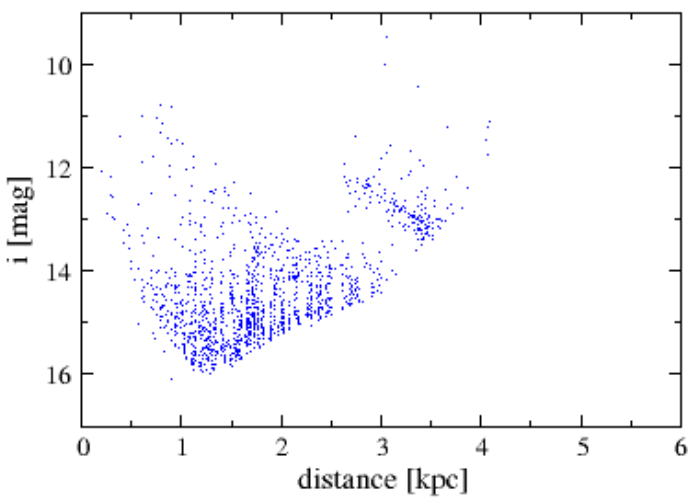


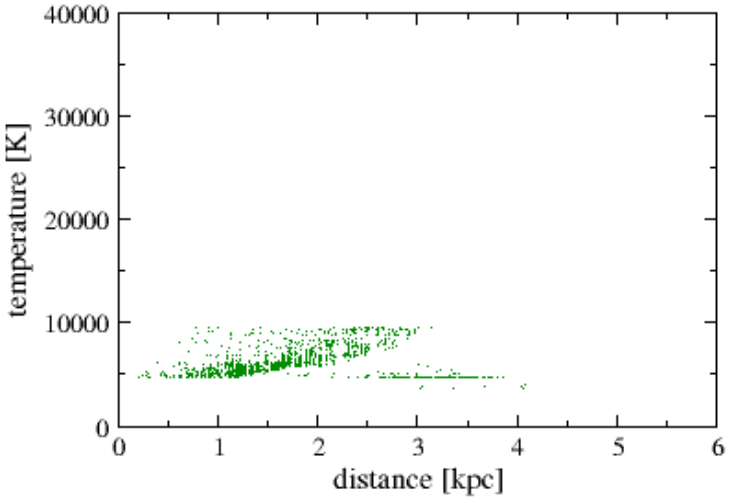


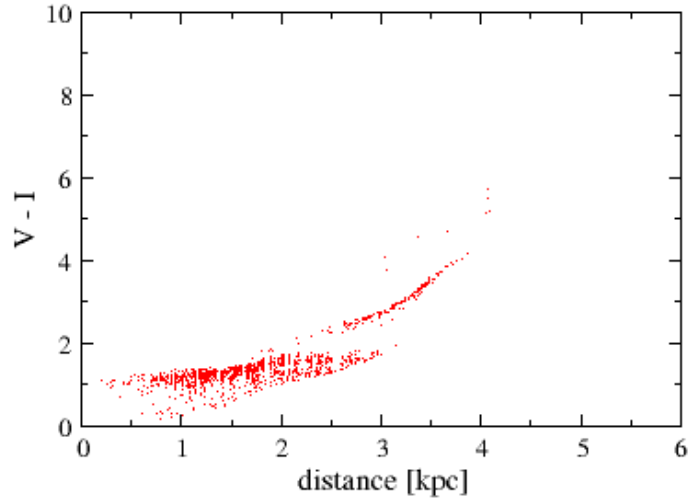
1867 stars

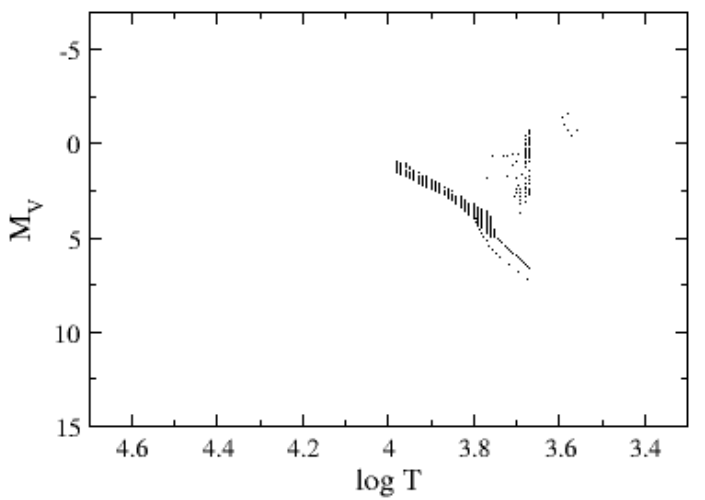
2286 stars

v_{err}<1km/s

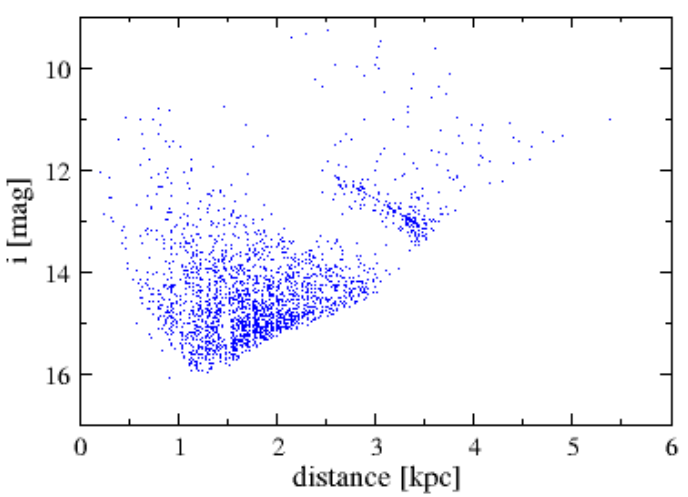

i [mag]
distance [kpc]

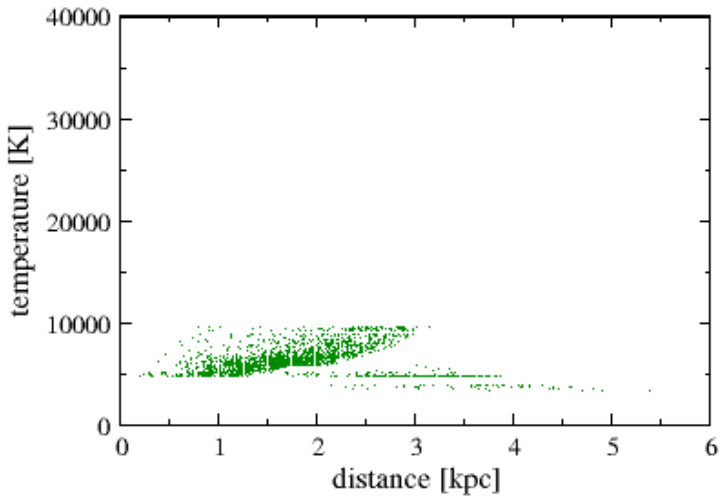

temperature [K]
distance [kpc]

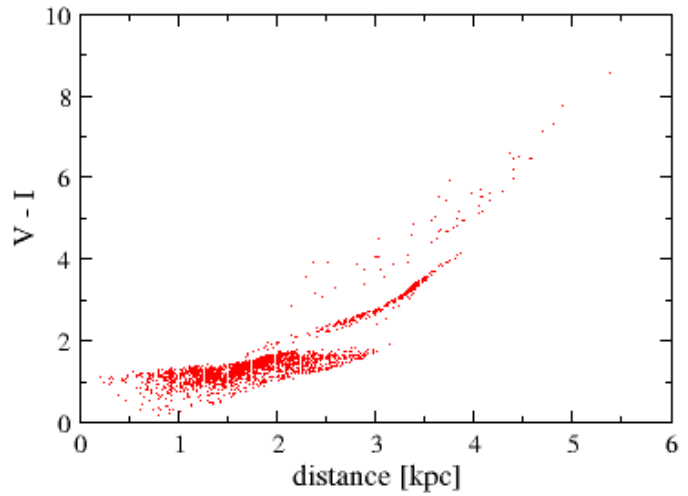

V - I
distance [kpc]

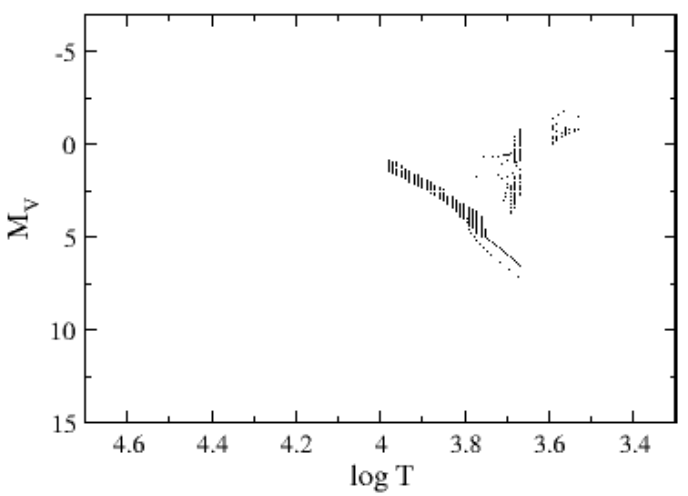

M_V
log T

v_{err}<30km/s

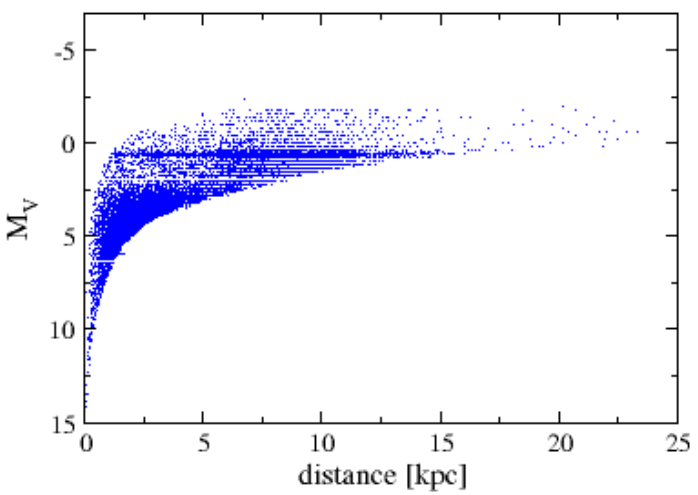

i [mag]
distance [kpc]

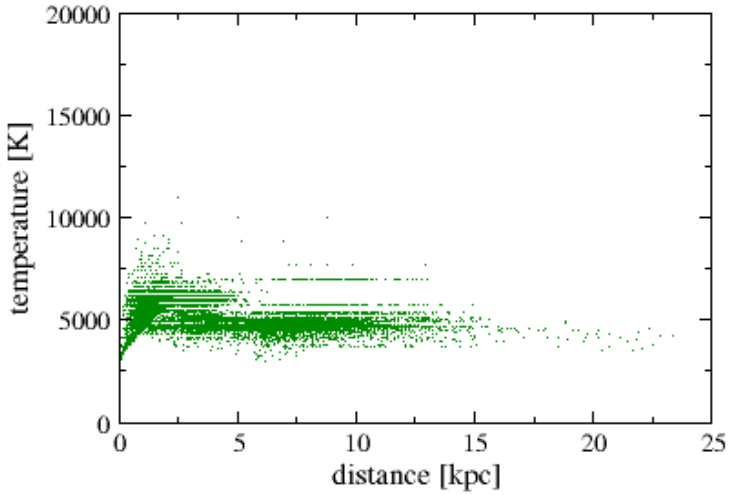

temperature [K]
distance [kpc]

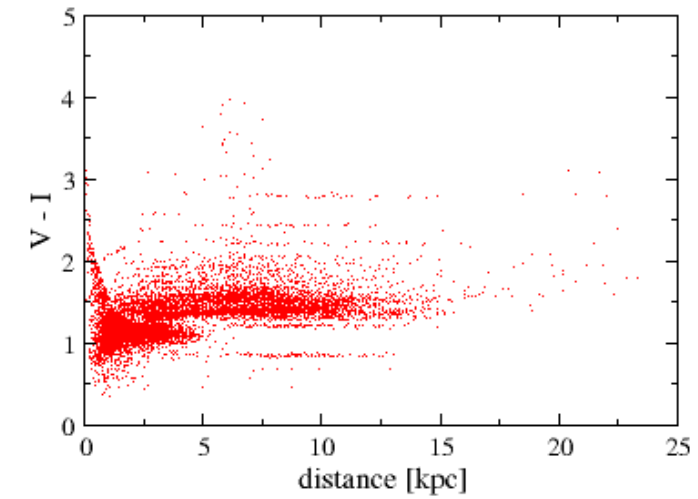

V - I
distance [kpc]

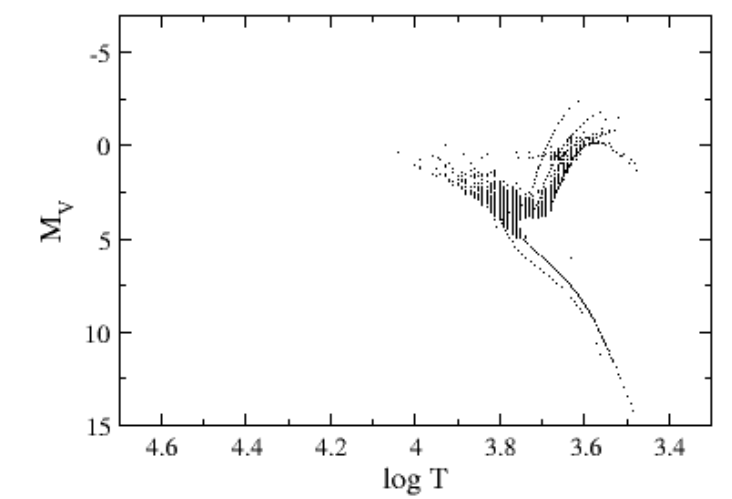

M_V
log T

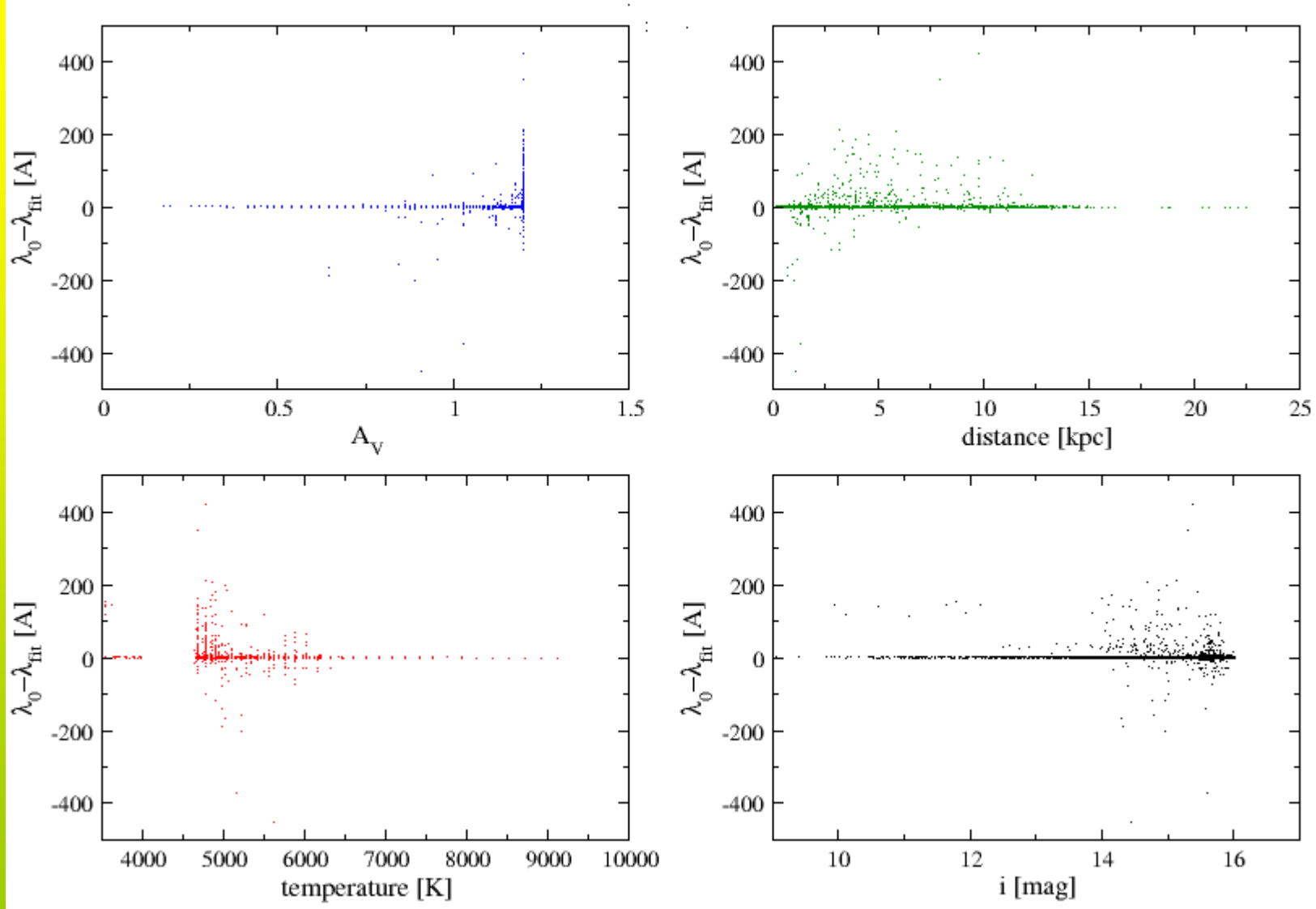
l=10º, b=10º, 7126/11193 stars

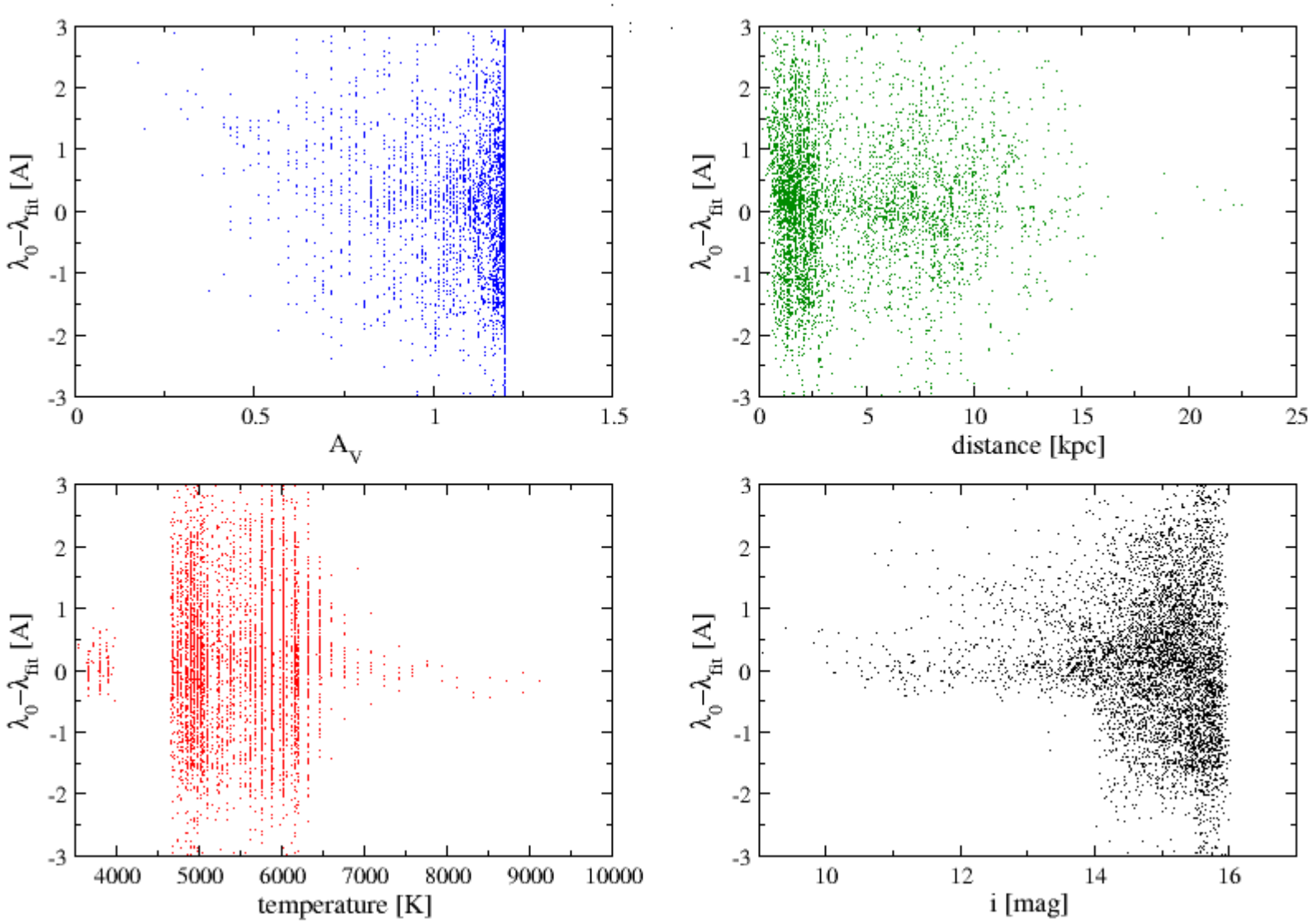






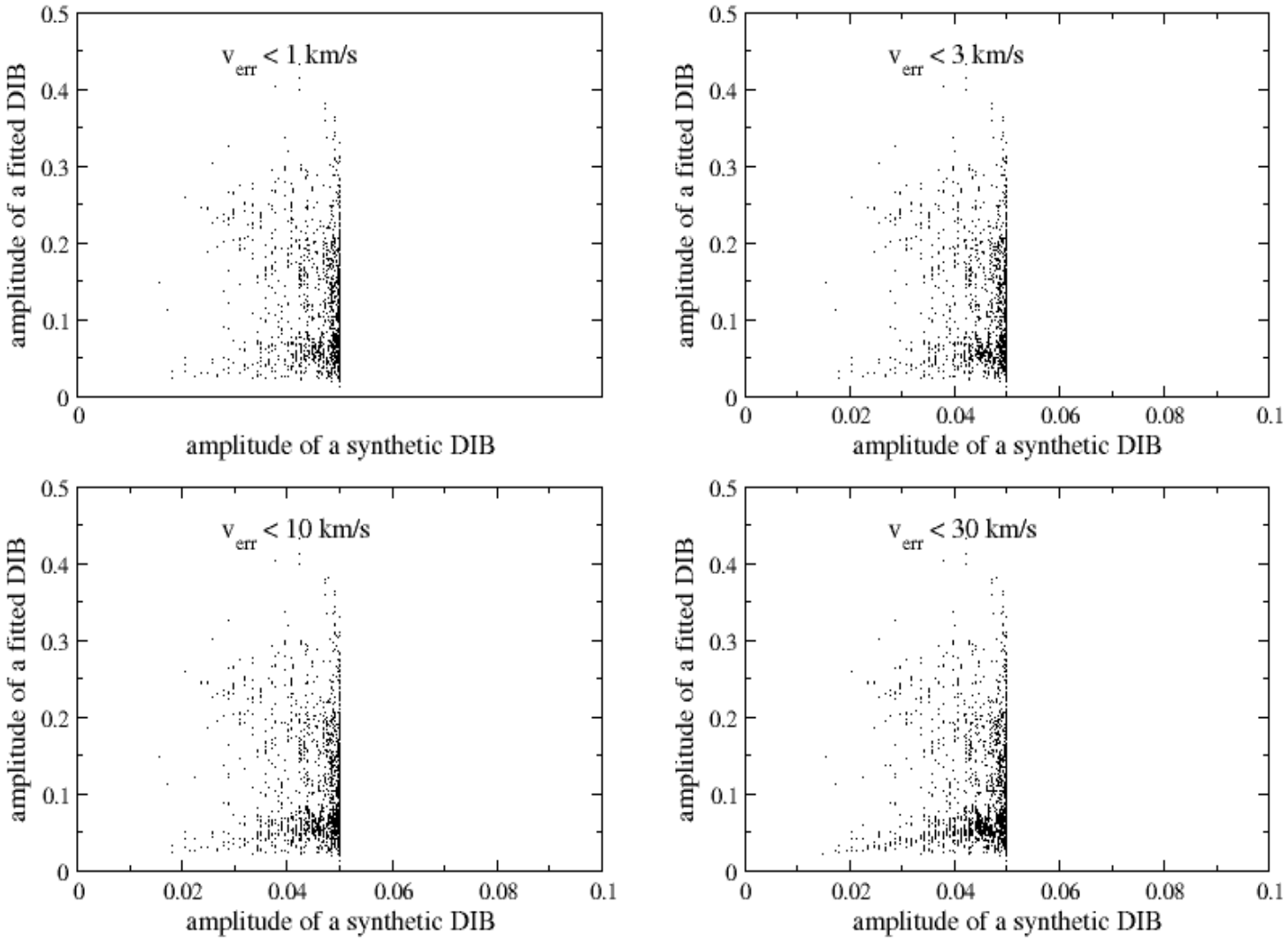



$\lambda_0-\lambda_{fit}$ [A]
400
200
0
-200
-400
0
0.5
1
1.5
A_V
$\lambda_0-\lambda_{fit}$ [A]
400
200
0
-200
-400
0
5
10
15
20
25
distance [kpc]
$\lambda_0-\lambda_{fit}$ [A]
400
200
0
-200
-400
4000
5000
6000
7000
8000
9000
10000
temperature [K]
$\lambda_0-\lambda_{fit}$ [A]
400
200
0
-200
-400
10
12
14
16
i [mag]


λ0−λfit [A]
A_V
distance [kpc]
temperature [K]
i [mag]

2888 stars

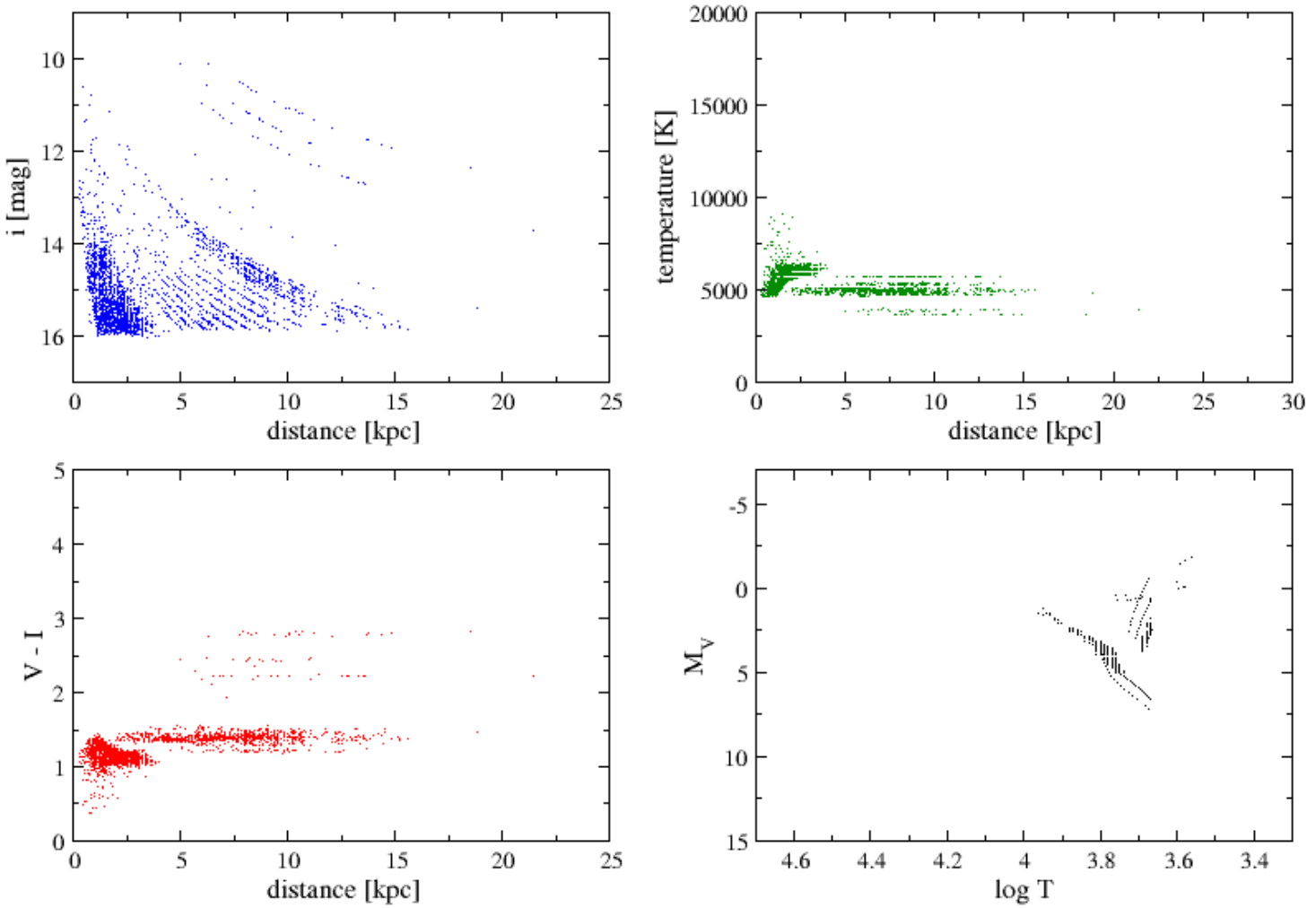
3055 stars



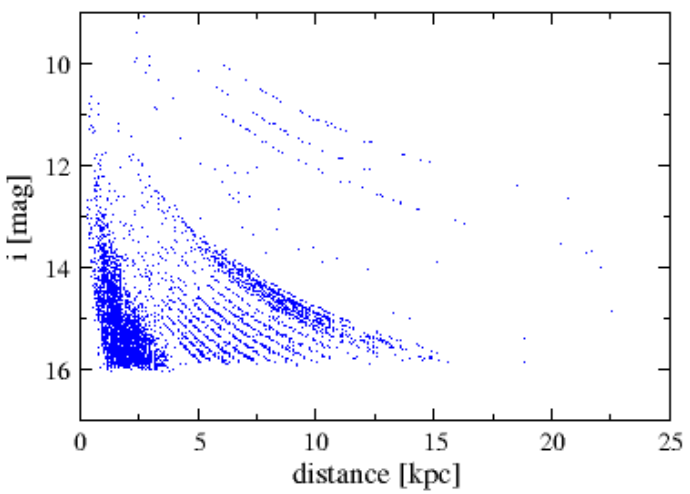
3578 stars

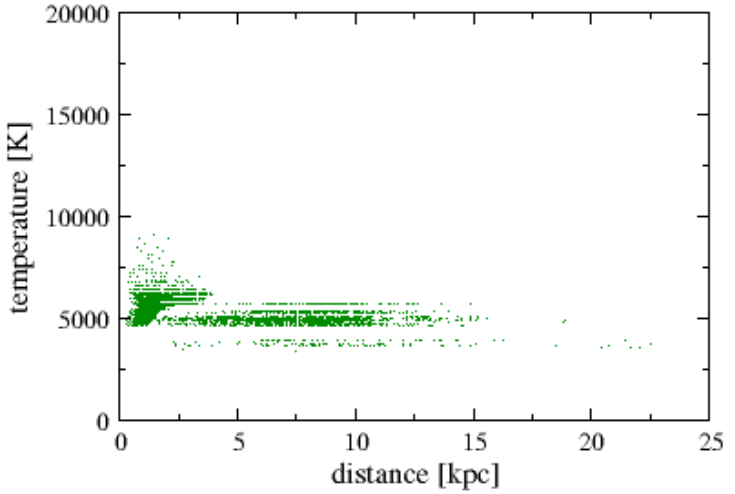
4581 stars

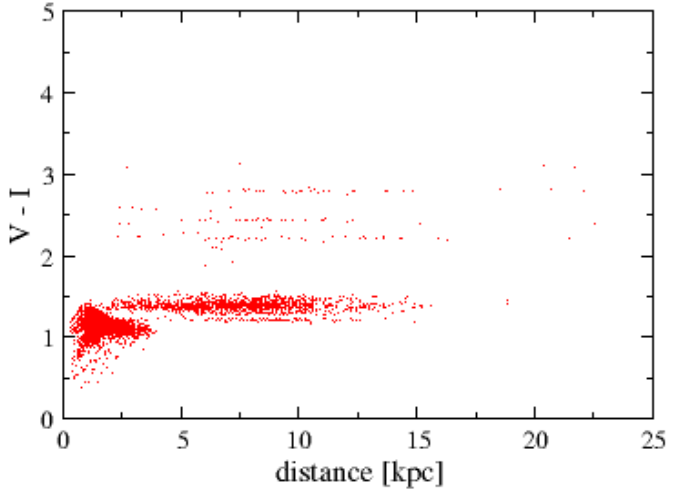
v_{err}<1km/s

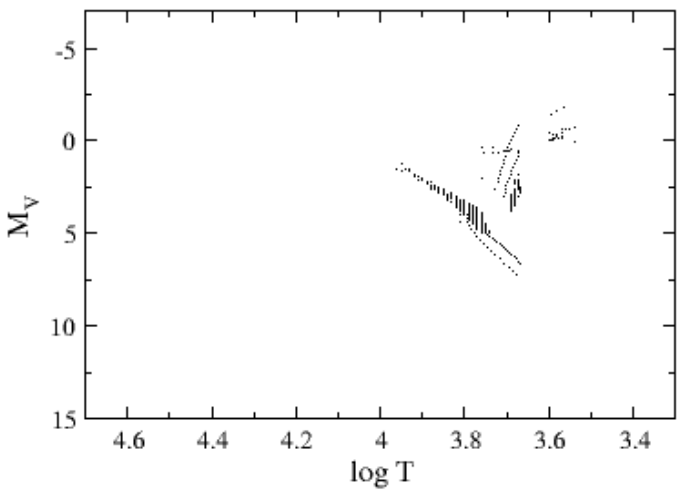

i [mag]
distance [kpc]
temperature [K]
distance [kpc]
V - I
distance [kpc]
M_V
log T

v_{err}<30km/s

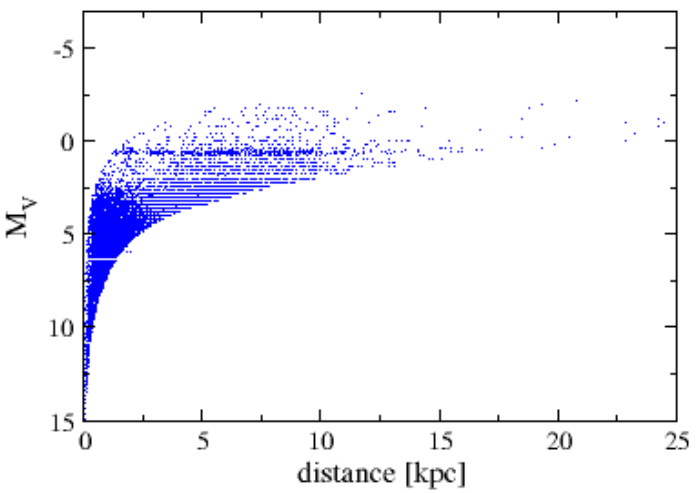

i [mag]
distance [kpc]

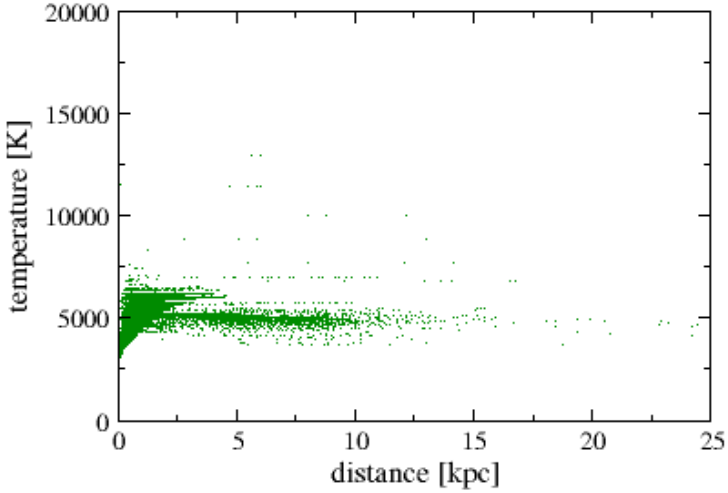

temperature [K]
distance [kpc]

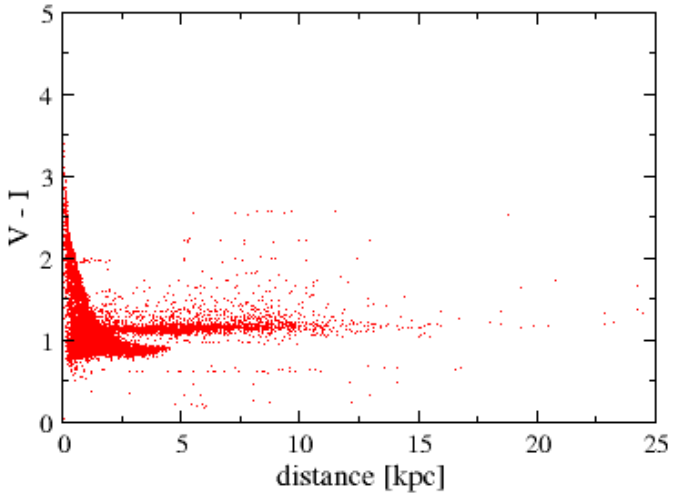

V - I
distance [kpc]

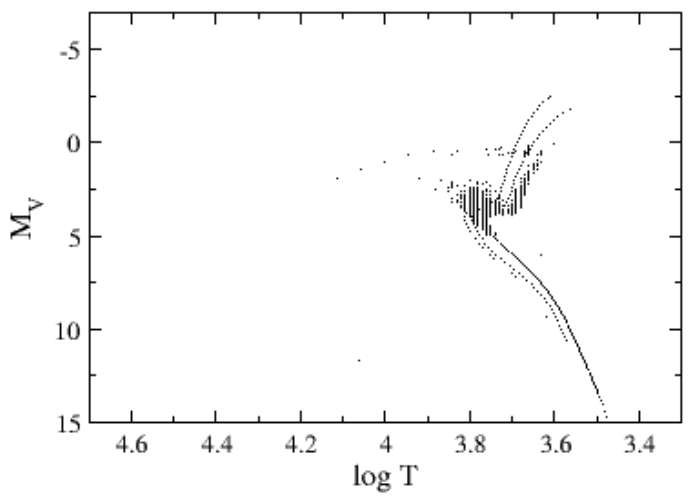

M_V
log T

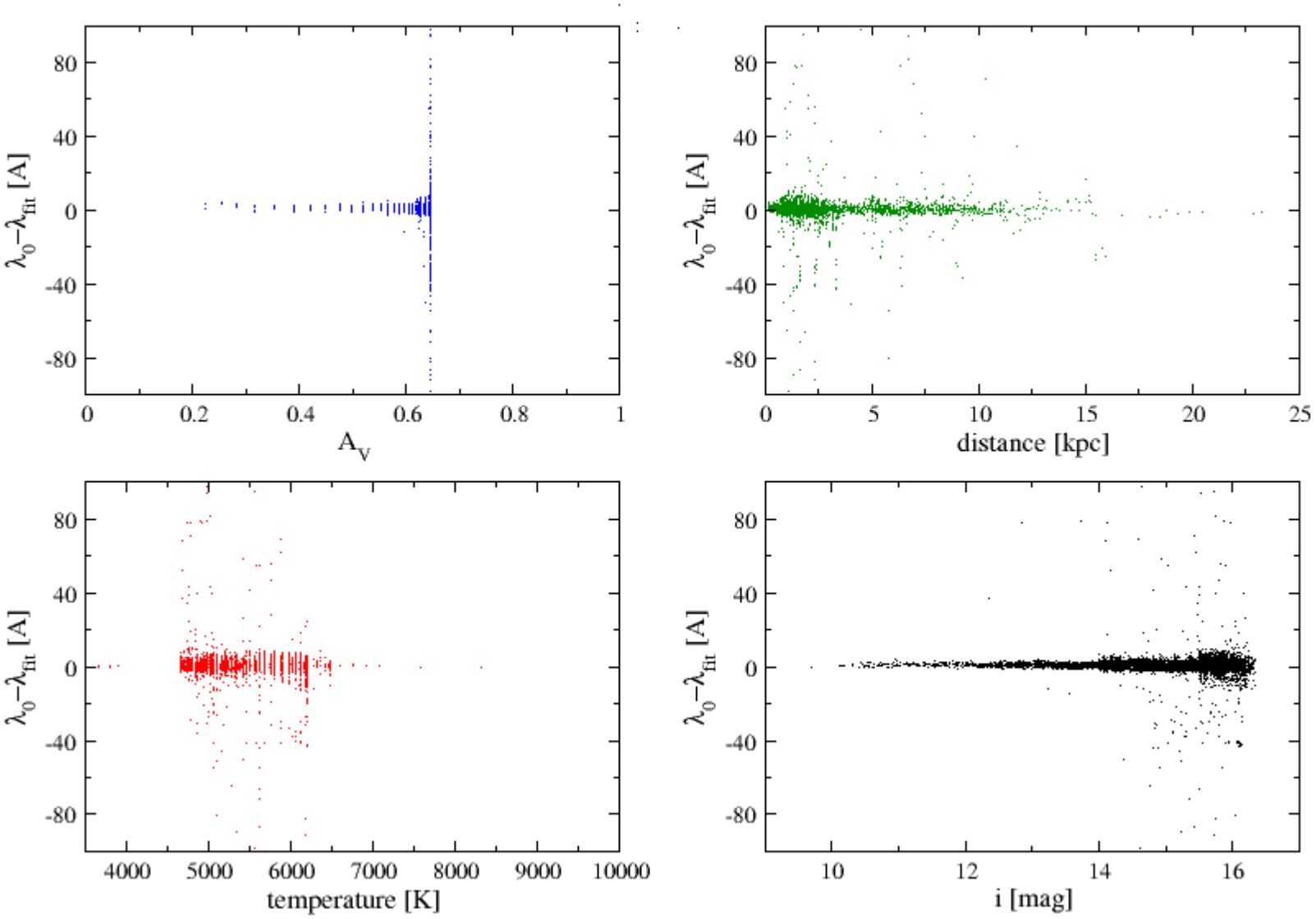
l=10°, b=30°, 7878/11360 stars

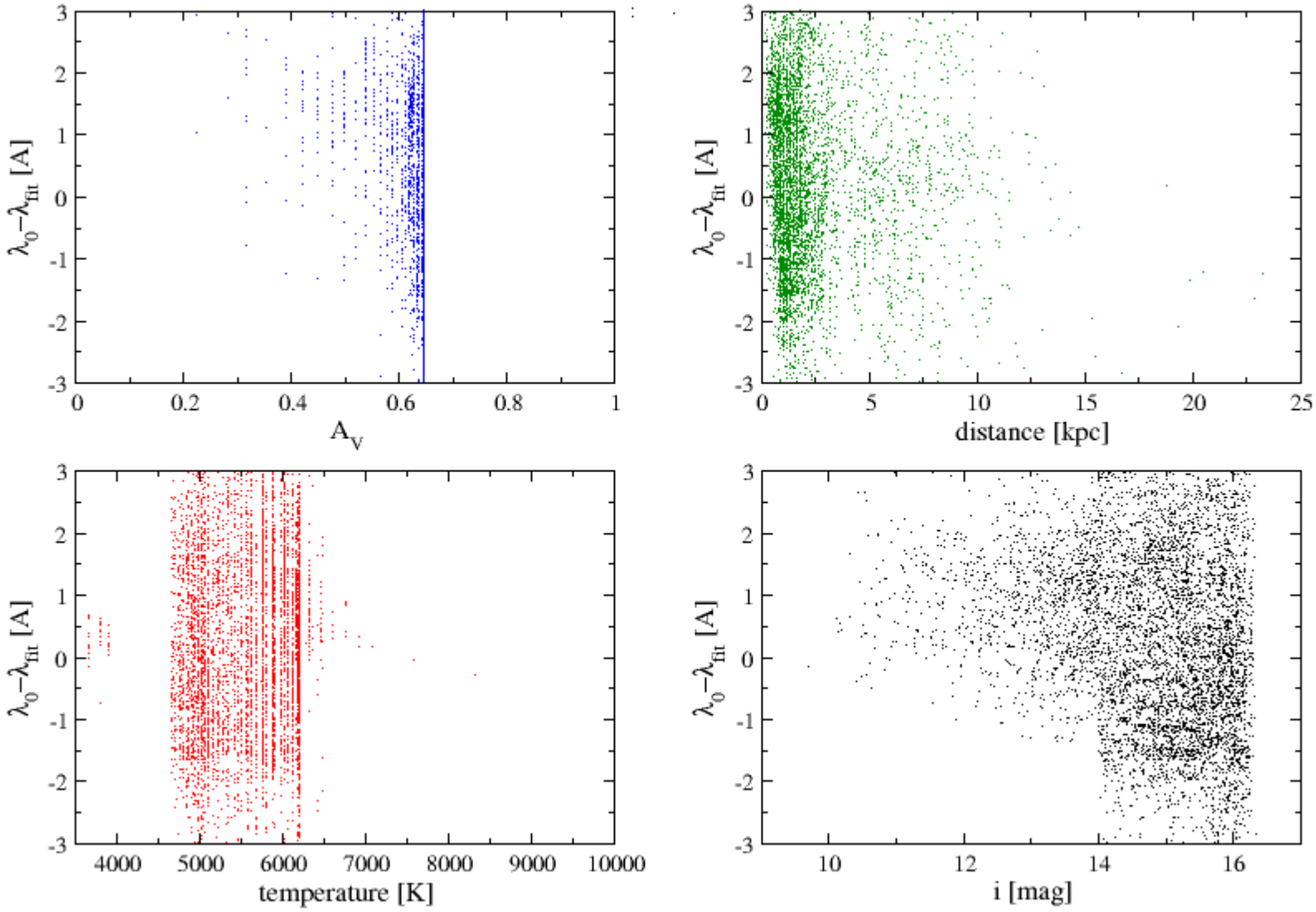






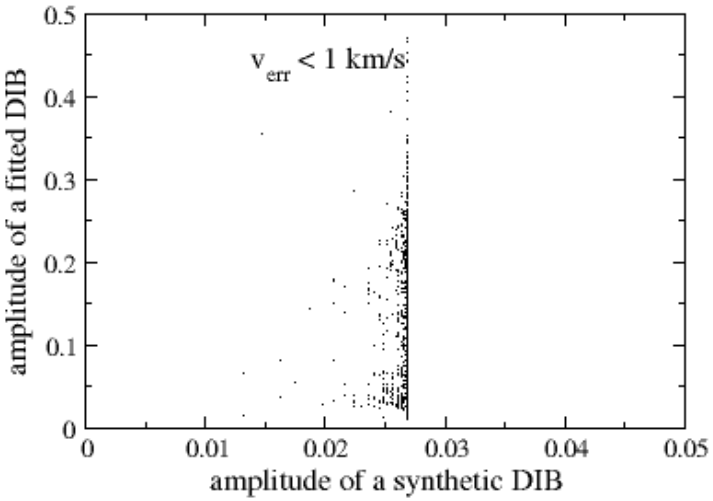


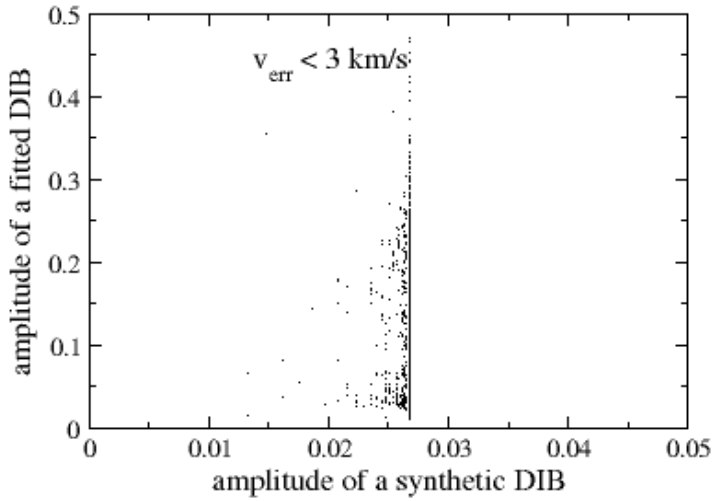

80
40
0
-40
-80
$\lambda_0-\lambda_{fit}$ [A]
0
0.2
0.4
0.6
0.8
1
A_V
0
5
10
15
20
25
distance [kpc]
4000
5000
6000
7000
8000
9000
10000
temperature [K]
10
12
14
16
i [mag]

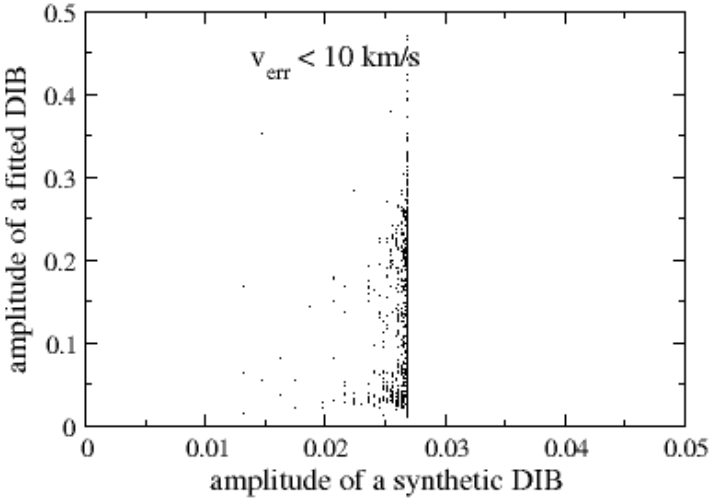

λ0−λfit [A]
AV
distance [kpc]
temperature [K]
i [mag]

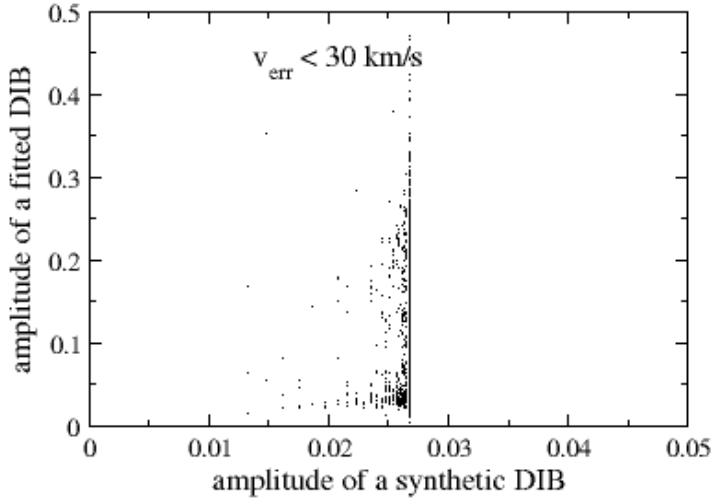
3310 stars

3394 stars





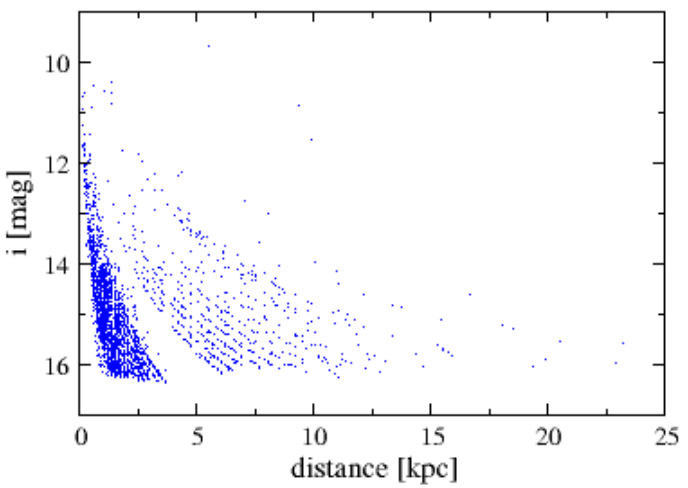


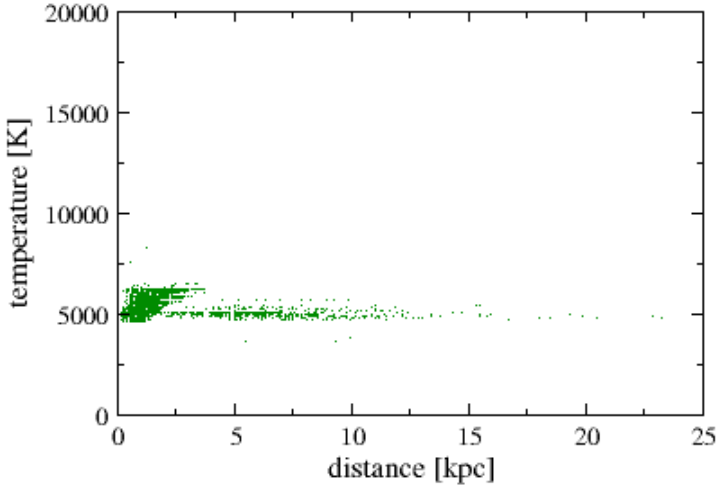


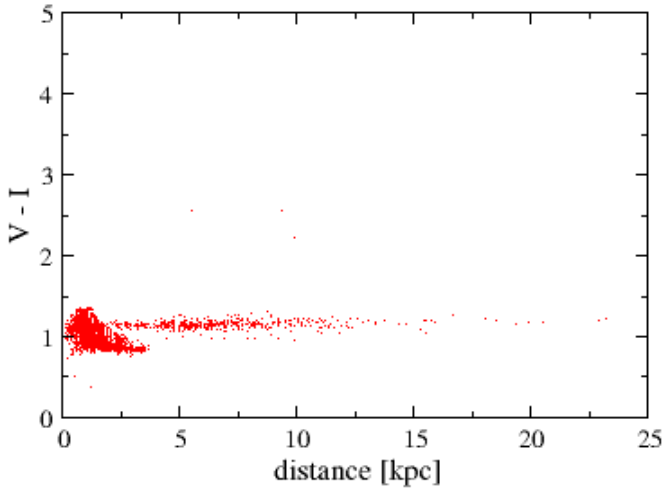
3687 stars

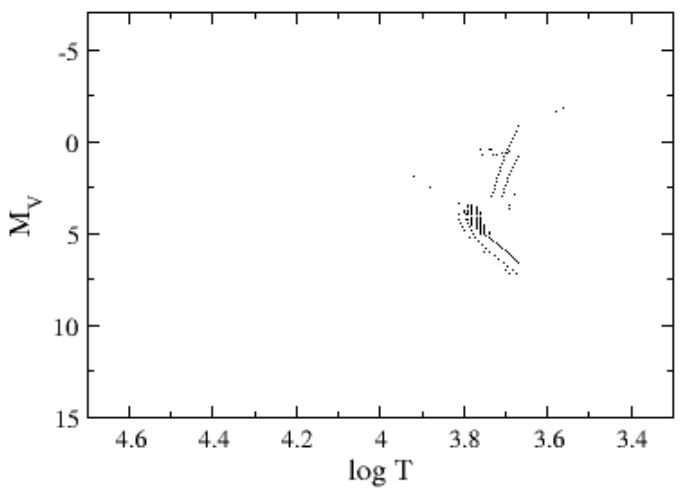
4422 stars

v_{err}<1km/s

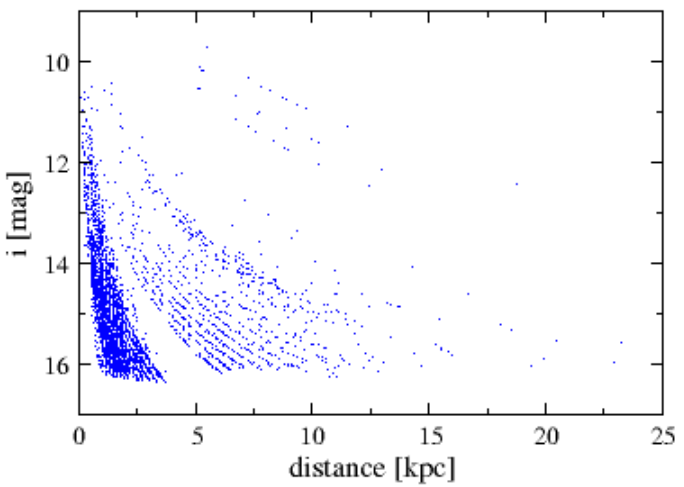

i [mag]
distance [kpc]

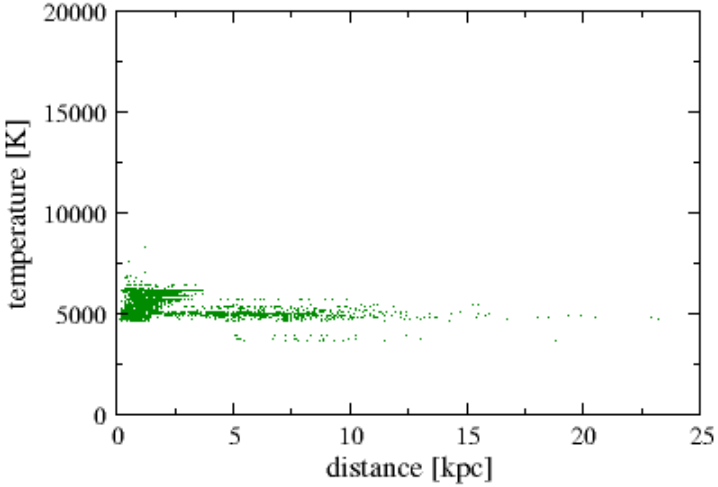

temperature [K]
distance [kpc]

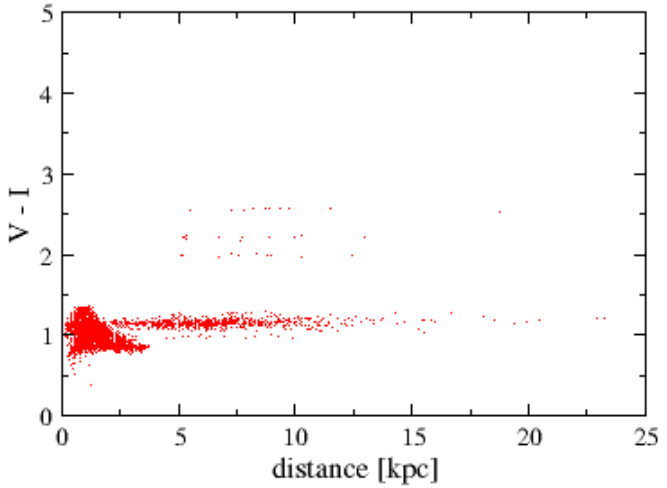

V - I
distance [kpc]

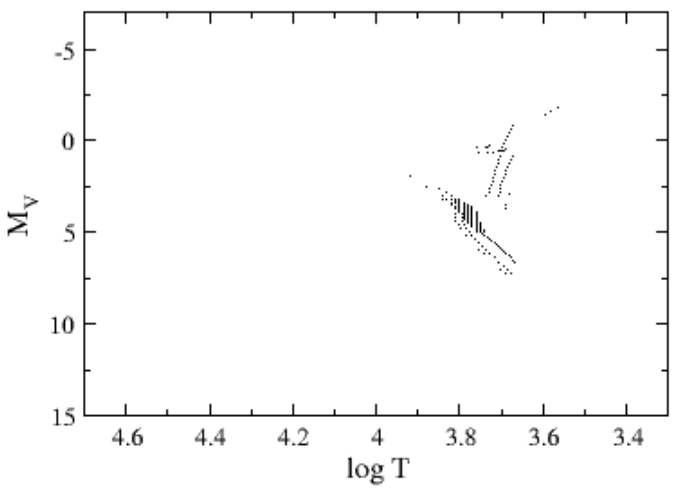

M_V
log T

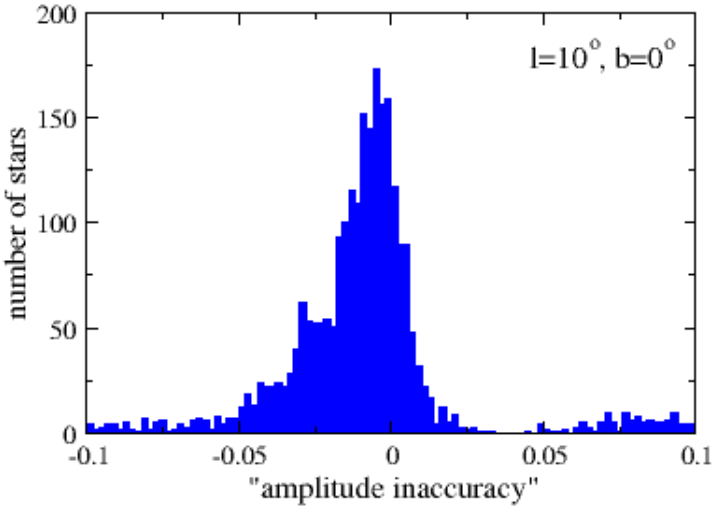
v_{err}<30km/s

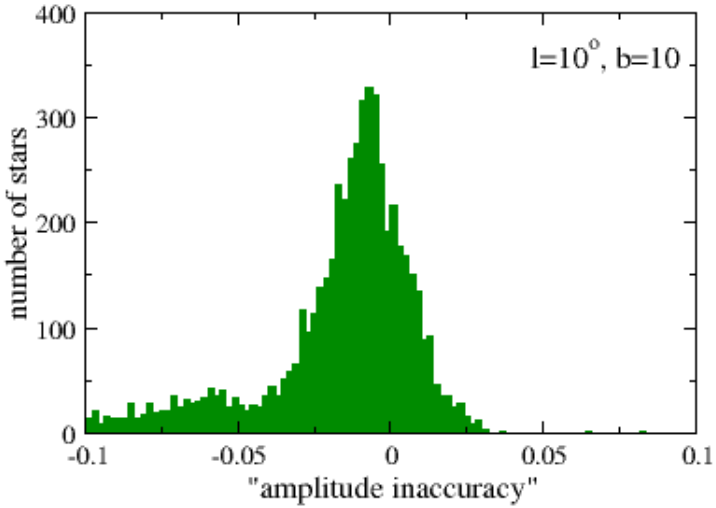

i [mag]
distance [kpc]

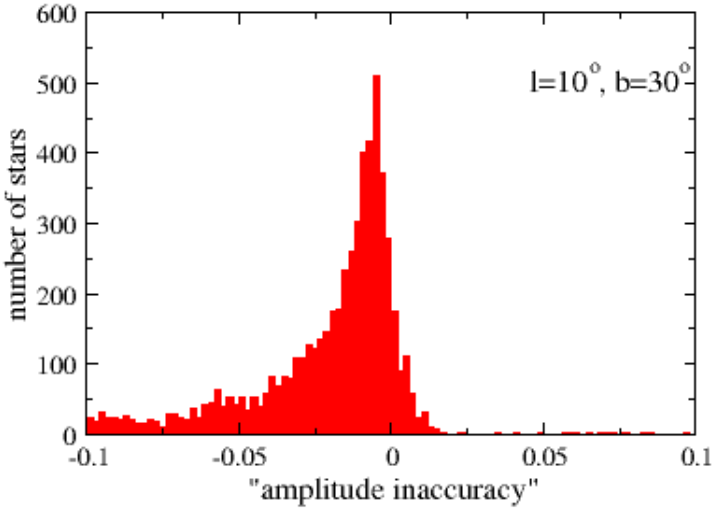

temperature [K]
distance [kpc]

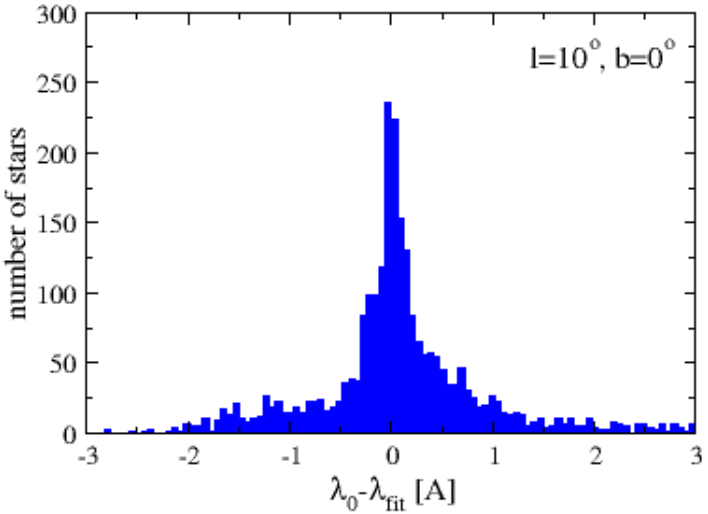

V - I
distance [kpc]

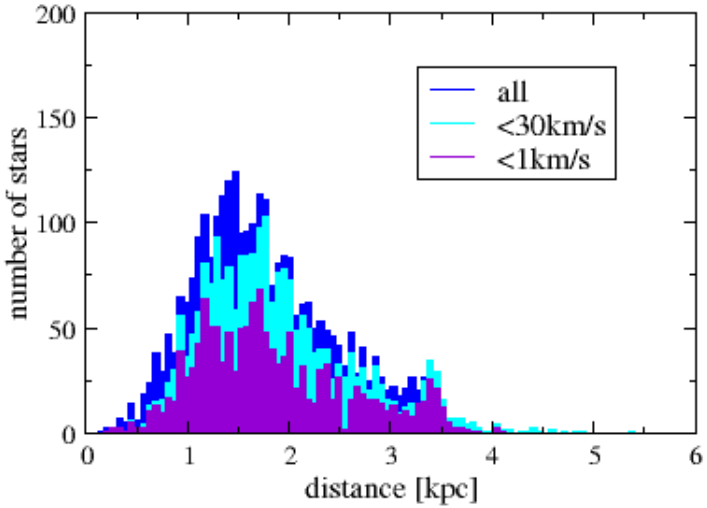

M_V
log T

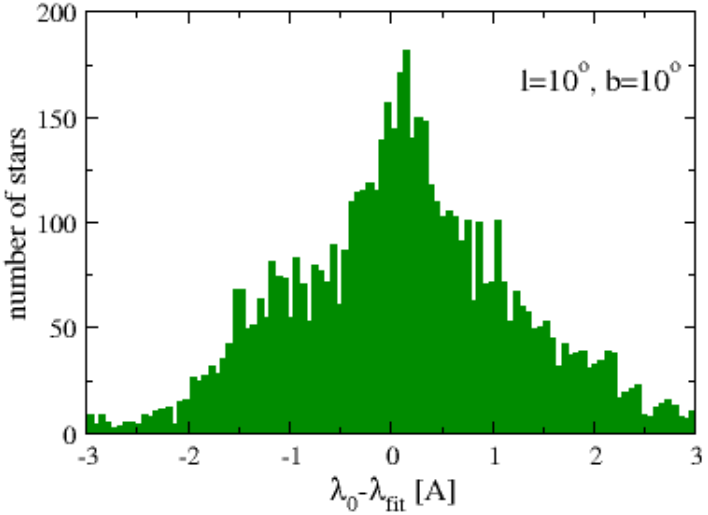

l=10°, b=0°
number of stars
"amplitude inaccuracy"
200
150
100
50
0
-0.1
-0.05
0
0.05
0.1

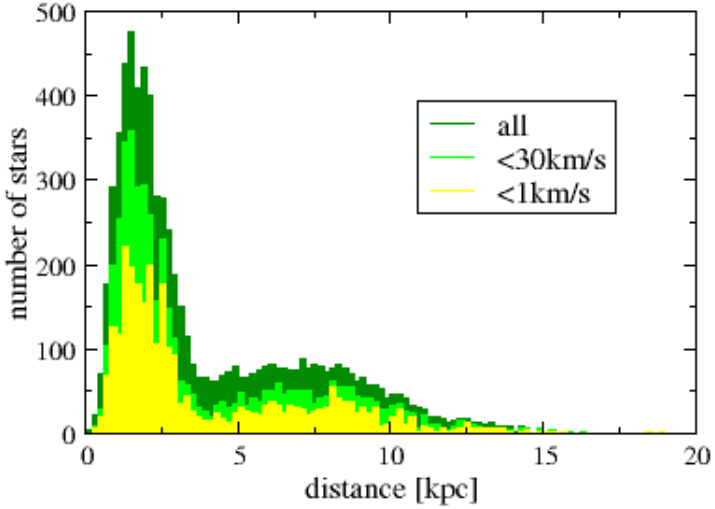

l=10°, b=10
number of stars
"amplitude inaccuracy"
400
300
200
100
0
-0.1
-0.05
0
0.05
0.1


l=10°, b=30°
number of stars
"amplitude inaccuracy"
600
500
400
300
200
100
0
-0.1
-0.05
0
0.05
0.1


l=10°, b=0°
number of stars
λ0-λfit [A]


all
<30km/s
<1km/s
number of stars
distance [kpc]


l=10°, b=10°
number of stars
λ0-λfit [A]


all
<30km/s
<1km/s
number of stars
distance [kpc]

- Results:
  - in Galactic plane huge A_V:
    - strong imprint of DIB
      - » range ~4 kpc
    - strong decay of magnitude
  - away from the Galactic plane, A_V “soon” reaches constant value:
    - weak imprint of A_V
      - » range ~ 10-15kpc
    - weak extinction
  - Is the DIB survey range limited by simulated sample?
- Future work:
  - the whole synthetic spectra grid
  - grid of several Galactic directions
  - better S/N treatment
  - ...