STELLAR ATMOSPHERES IN THE GAIA ERA. GREAT-ESF WORKSHOP

Stellar Physics with the ALHAMBRA Photometric System

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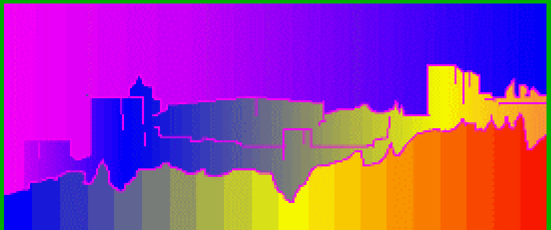


The ALHAMBRA photometric system

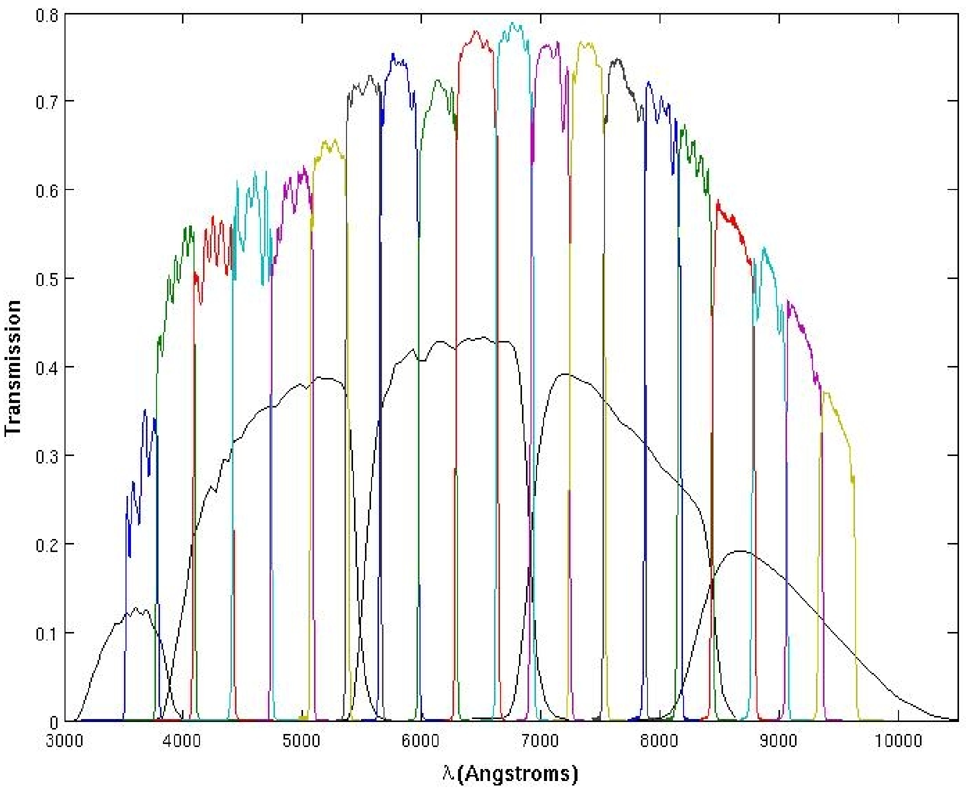
The ALHAMBRA project (Moles et al. 2008):
perform a tomography of the universe in some selected areas conforming almost 4 deg² in 8 non-contiguos regions of the sky.

Photometric system :

20 constant-width, non-overlapping medium-band filters and with uniform transmission, in the optical range($Alh_i, i = 1{:}20$) and three bands in the infrared according with the classical JHKs bands.

(T. Aparicio Villegas et al. 2010)

Optical ALHAMBRA photometric system



Stellar classification and physical parameter estimation from ALHAMBRA optical photometry

Reddening-free Q - parameters

$$Q_{ijkl} = m_i - m_j - \frac{E_{ij}}{E_{kl}} \left(m_k - m_l \right)$$

$$E_{ij} = A_i - A_j$$

Which one??

- **Not dependence of distances**
- **Not dependence of reddening**
- **Depends on an extinction law**

Stellar classification and physical parameter estimation from ALHAMBRA photometry : METHODOLOGY

1. Generation of 18 independent Q parameters from ALHAMBRA photometry: theoretical spectra and observed spectra:

$$Q_{ijk} = Alh_i - Alh_j - \frac{E_{ij}}{E_{jk}} \left(Alh_j - Alh_k \right)$$

2. Estimation of physical parameters : Teff, logg and [Fe/H] directly from the models

3. E(B-V)??
The model photometry gives us 19 unreddened ALHAMBRA colors :

$$Alh_i - Alh_{i+\square}, i = \text{١:١٩}$$

And,

$$E\left(B-V\right) = median_{[i]}\left(\alpha_i \cdot E\left(Alh_i - Alh_{i+1}\right)_i\right), i = 1{:}19$$

OTHER FACTORS TO TAKE INTO ACCOUNT...

1. Zero point corrections from ALHAMBRA photometry to synthetic photometry of the models

2. Choice of the best extinction law to be applied on our data: functional criteria

METHODOLOGY

1. Generation of 18 independent Q parameters from ALHAMBRA photometry: theoretical spectra and observed spectra:

$$Q_{ijk} = Alh_i - Alh_j - \frac{E_{ij}}{E_{jk}}\left(Alh_j - Alh_k\right), j=i+1, k=i+2$$

Next Generation Spectral Library (Gregg et al. 2004)

MODELS

BaSeL 2.2
(Lejeune et al. 1998)

White Dwarfs Templates (Holberg & Bergeron, 2006)

288 observed spectra with synthetic photometry from NGSL:

$$3440K \leq T_{eff} \leq 44500K$$
$$0.45 \leq \log g \leq 7.5$$
$$-2.9 \leq met \leq 0.7$$

These stars form part of the set of primary standard stars of the ALHAMBRA photometric system

METHODOLOGY

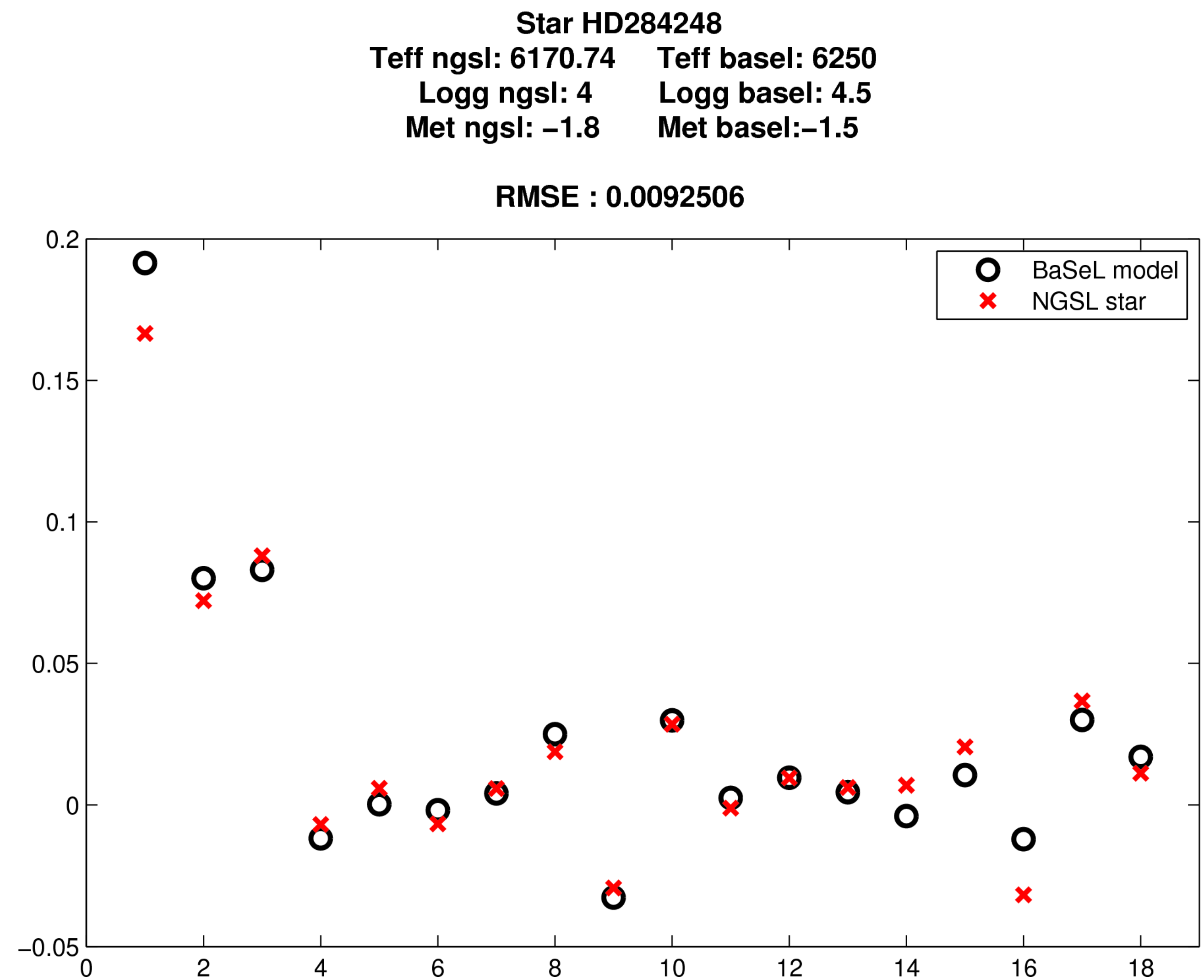
2. Estimation of physical parameters : Teff, logg and [Fe/H] directly from the models

Considering the 18 dimensional euclidean space formed by 18 independent Q parameters for each object, then, we look for the model which minimize the euclidean distance of both, the star and the model.

An example: HD284248

METHODOLOGY

2. Est **he**
model



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METHODOLOGY

E(B-V)

From the synthetic photometry of the model , we have 19 unreddened ALHAMBRA colors:

$$Alh_{0i} - Alh_{0(i+1)}, i = 1{:}19$$

With the reddened colors of the star, we can determine the color excess in each band:

$$E\left(Alh_{i} - Alh_{i+\square}\right) = \left(Alh_{\square i} - Alh_{\square(i+\square)}\right) - \left(Alh_{\square i} - Alh_{\square(i+\square)}\right), i = \text{١:١٩}$$

And so, we can generate 19 E(B-V) from each different color excess adopting an extinction law...the E(B-V) associated to the star would be the median of these 19 values:

$$E\left(B - V\right) = median_{[i]}\left(\alpha_{i} \cdot E\left(Alh_{i} - Alh_{i+\square}\right)_{i}\right), i = \text{١:١٩}$$

METHODOLOGY

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E ... 1:19

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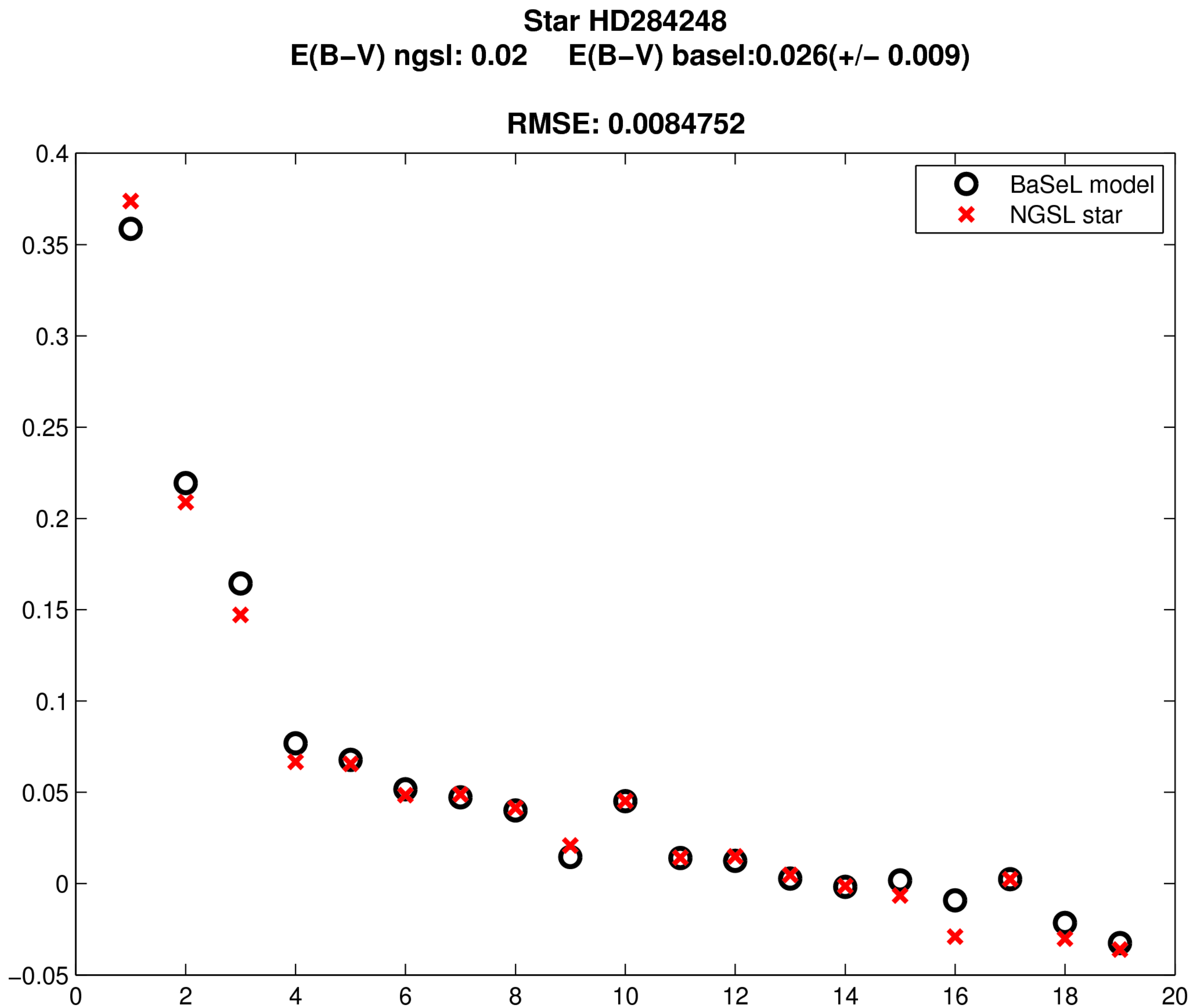


METHODOLOGY

Other things to take into account... ZERO POINT CORRECTIONS of the model photometry

1. **Execute the method with BaSeL synthetic photometry and the 288 stars from NGSL.**

2. **Between the 288 stars, select the ones which has a RMSE < 0.03 in the fit with the Q-parameters**

3. **For the 19 colors, calculate the differences between the dereddened color of the star and the synthetic color of the best model fit.**

4. **The offset to correct BaSeL photometry in each color, is the mean of those differences.**

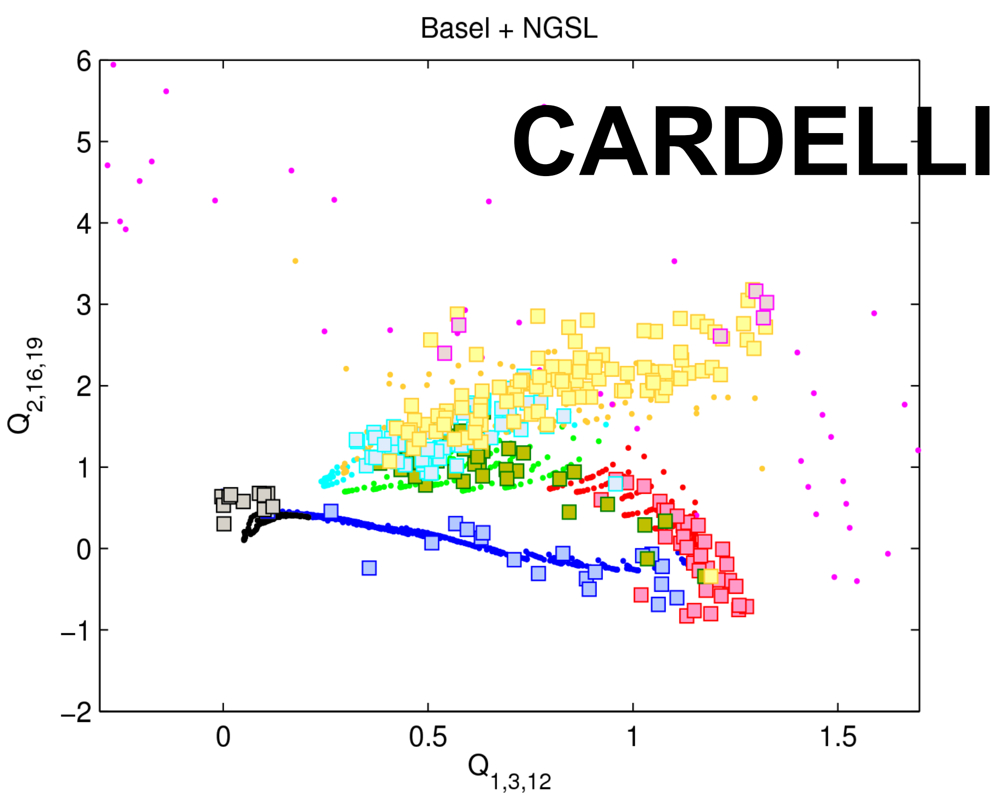
RESULT: Much better fits!!!
Reduce the RMSE for the cold stars

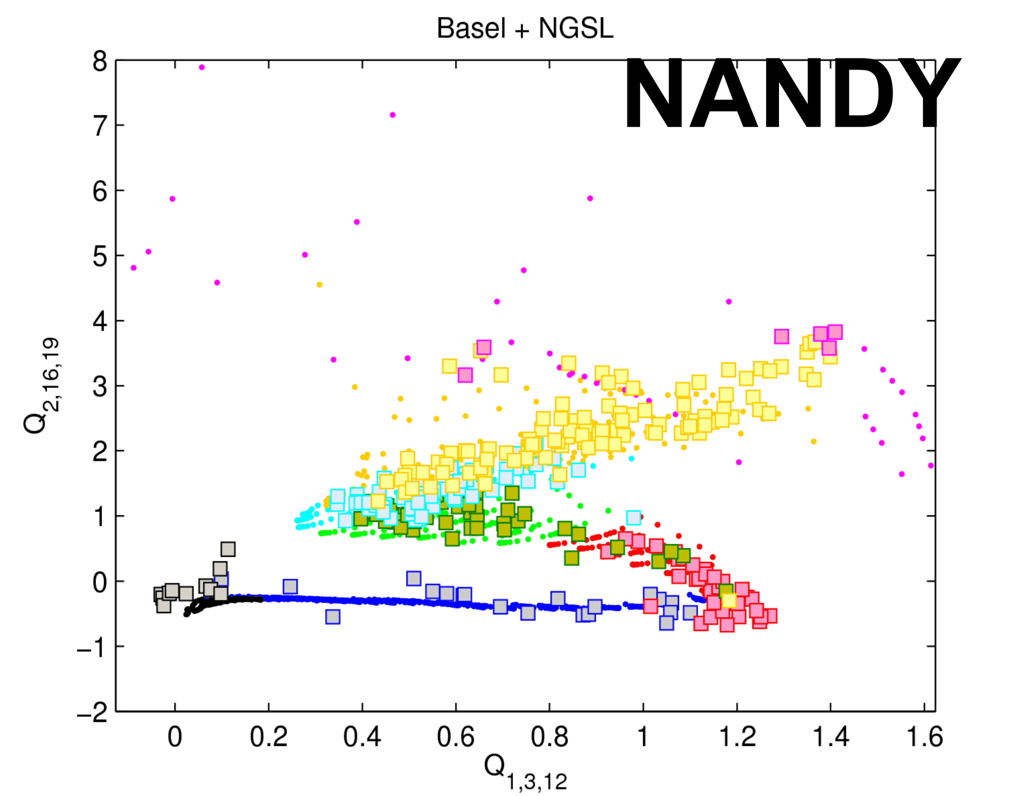
EXTINCTION LAW

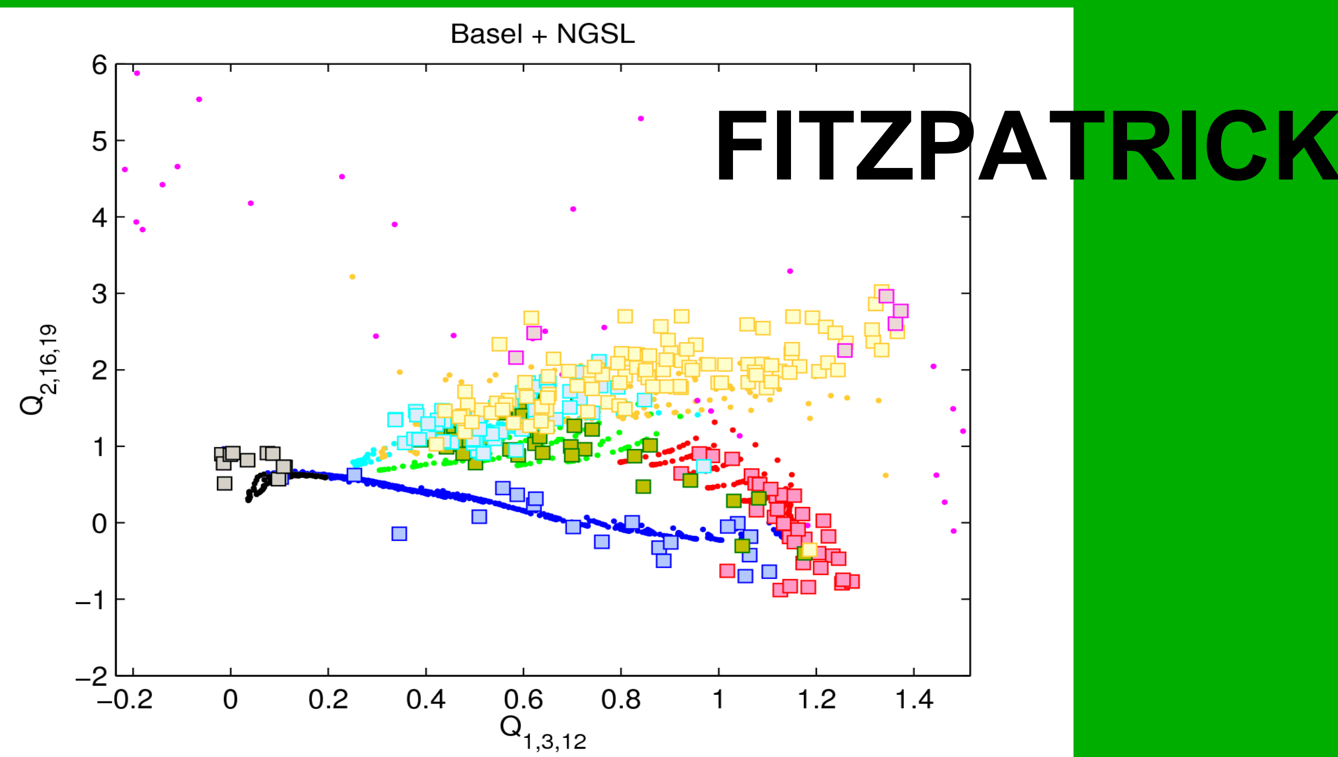
Other things to take into account... EXTINCTION LAW

Comparing three different Milky Way extinction laws:

Nandy et al.(1975)
Cardelli et al.(1989)
Fitzpatrick (1999)


Basel + NGSL
CARDELLI
$Q_{2,16,19}$
$Q_{1,3,12}$


Basel + NGSL
NANDY
$Q_{2,16,19}$
$Q_{1,3,12}$


Basel + NGSL
FITZPATRICK
$Q_{2,16,19}$
$Q_{1,3,12}$

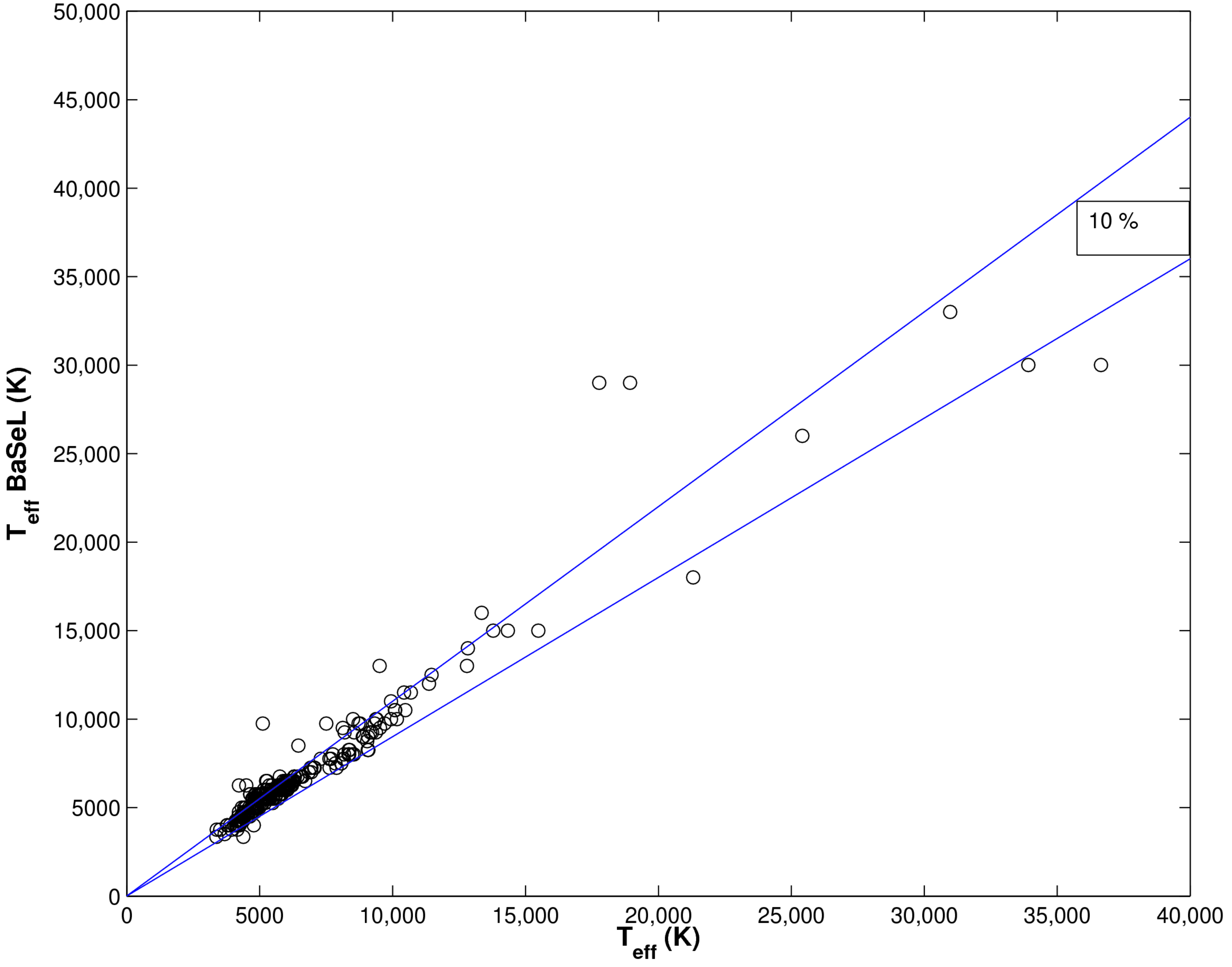
EXTINCTION LAW

Other things to take into account... EXTINCTION LAW

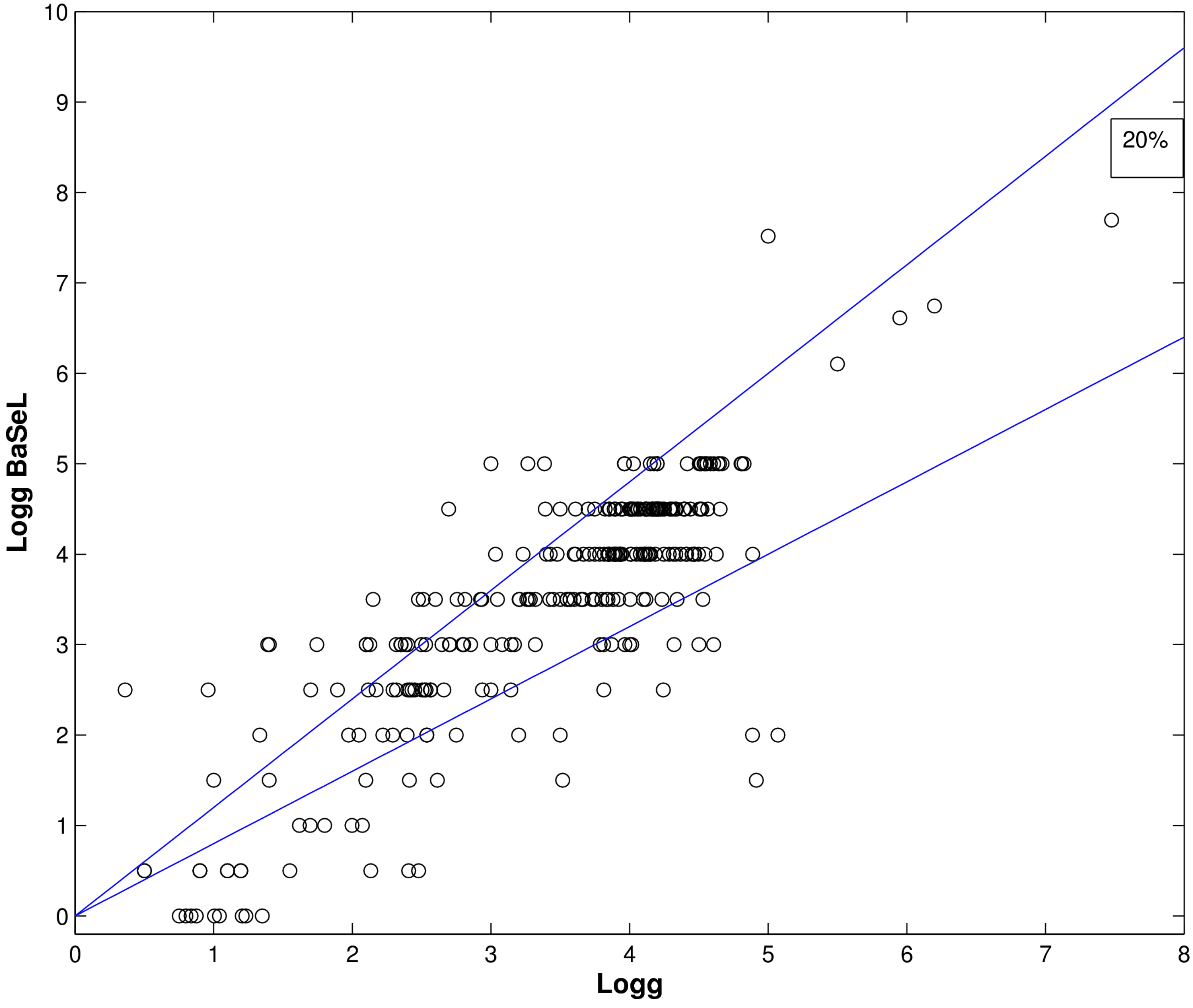
	NBC	NBO	CBC	CBO	FBC	FBO
Mean(MAD(E(B-V)))	0.065	0.086	0.055	0.07	0.061	0.073
Std(MAD(E(B-V)))	0.072	0.062	0.054	0.058	0.066	0.062
$\overline{\lvert\delta(E(B-V))\rvert}$	0.063	0.082	[illegible]	0.064	0.056	0.064
$\overline{\delta(E(B-V))}$	[illegible]	[illegible]	[illegible]	[illegible]	-0.035	-0.040
$\overline{\lvert\delta(T_{eff})\rvert}$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	555.14
$\overline{\delta(T_{eff})}$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-457.34
$\overline{\lvert\delta(logg)\rvert}$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.54
$\overline{\delta(logg)}$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-0.006
$\overline{\lvert\delta(Fe/H)\rvert}$	[illegible]	[illegible]	[illegible]	[illegible]	0.46	0.49
$\overline{\delta(Fe/H)}$	-0.29	-0.30	-0.31	-0.26	-0.23	-0.23

Mean(MAD(E(B-V)) gives us an estimate of the internal precision. This EL provides the best internal precision in the estimation of the color excess

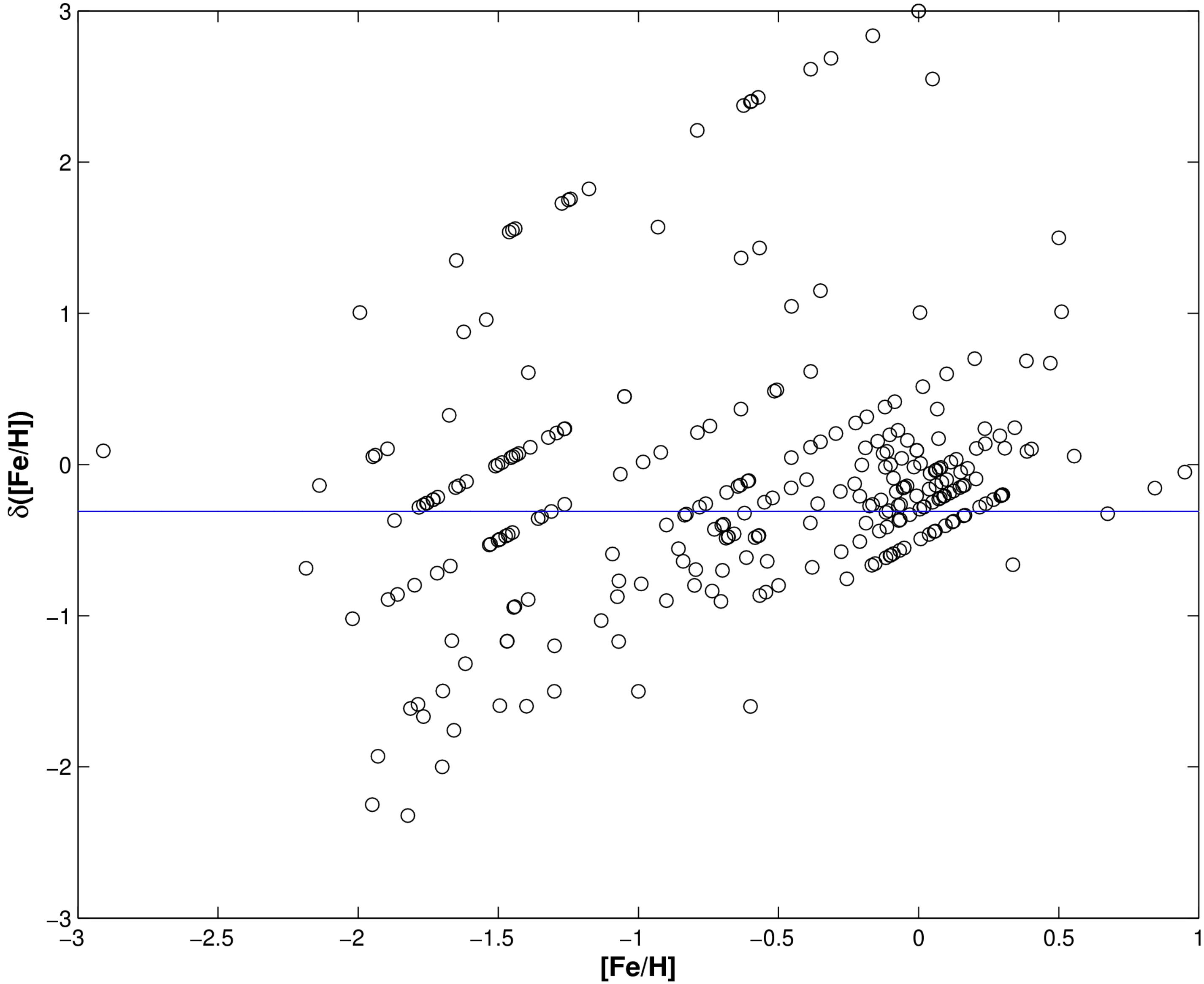
GENERAL RESULTS



GENERAL RESULTS



GENERAL RESULTS



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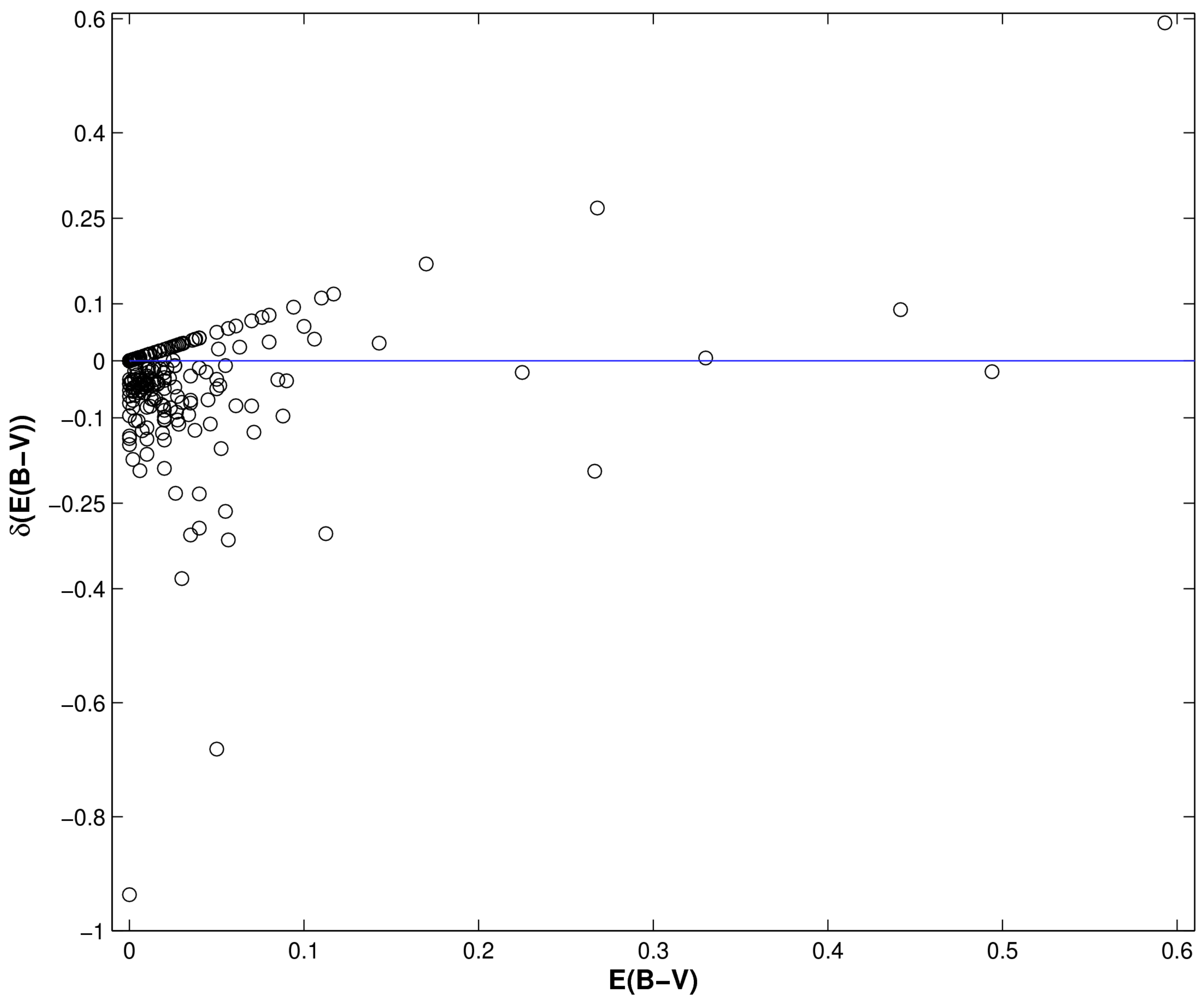
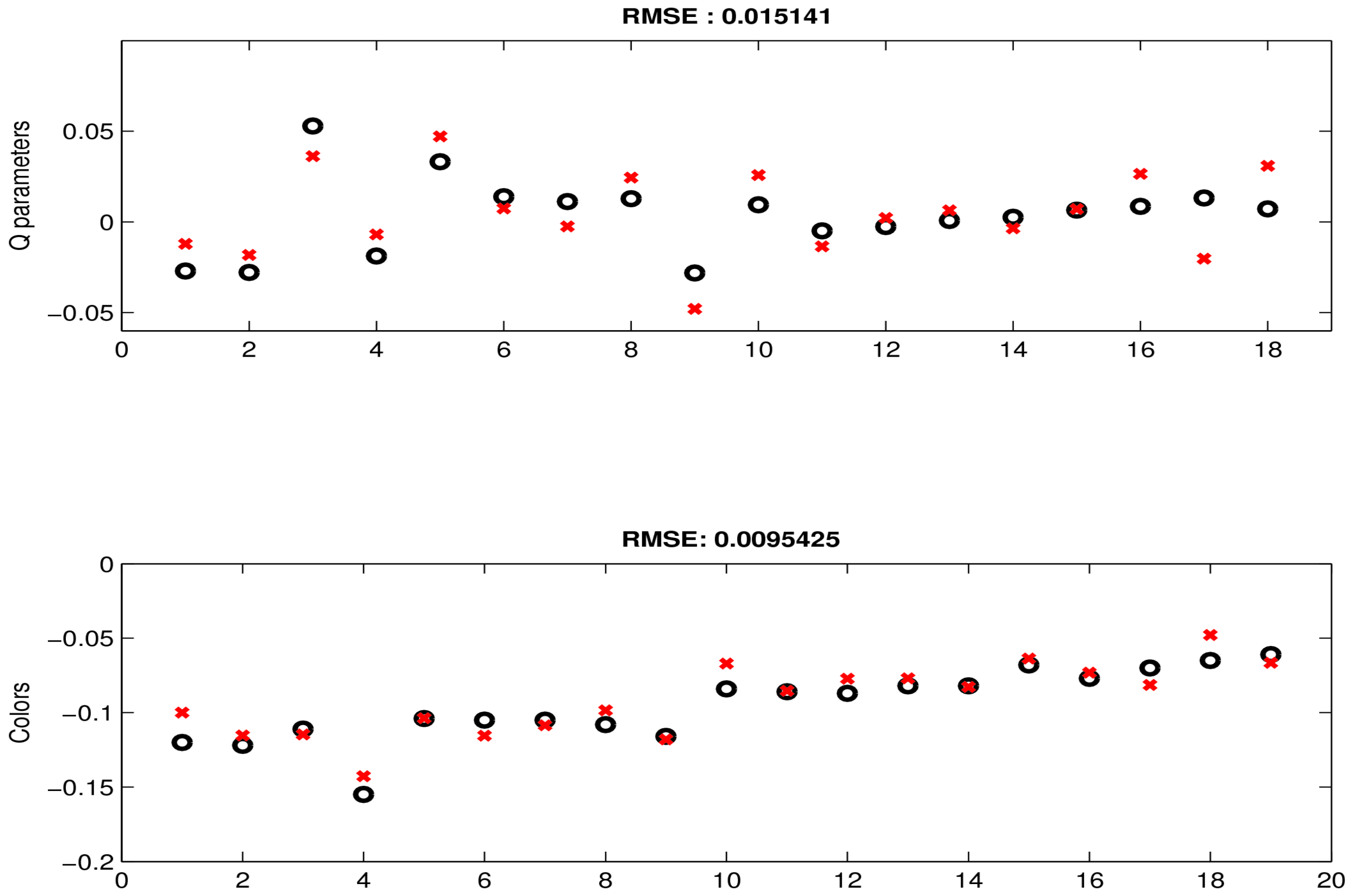


WHITE DWARFS

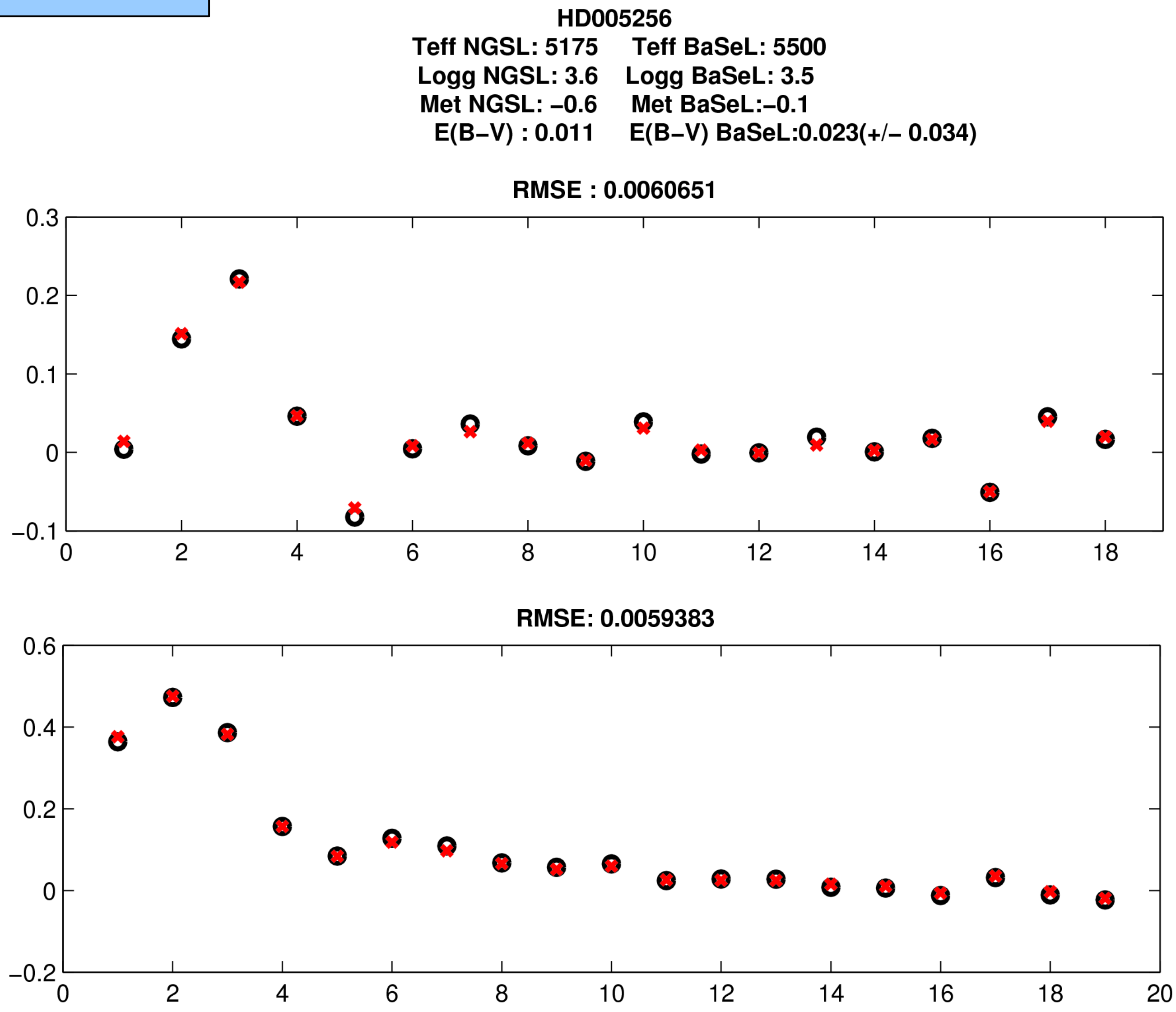
Feige 110

Teff (Friedman et al.2002) : 42300   Teff Model: 55000
Logg(Friedman et al.2002) : 5.95   Logg Model: 6.47
E(B-V) :NA   E(B-V) fit :0.021(+/- 0.051)



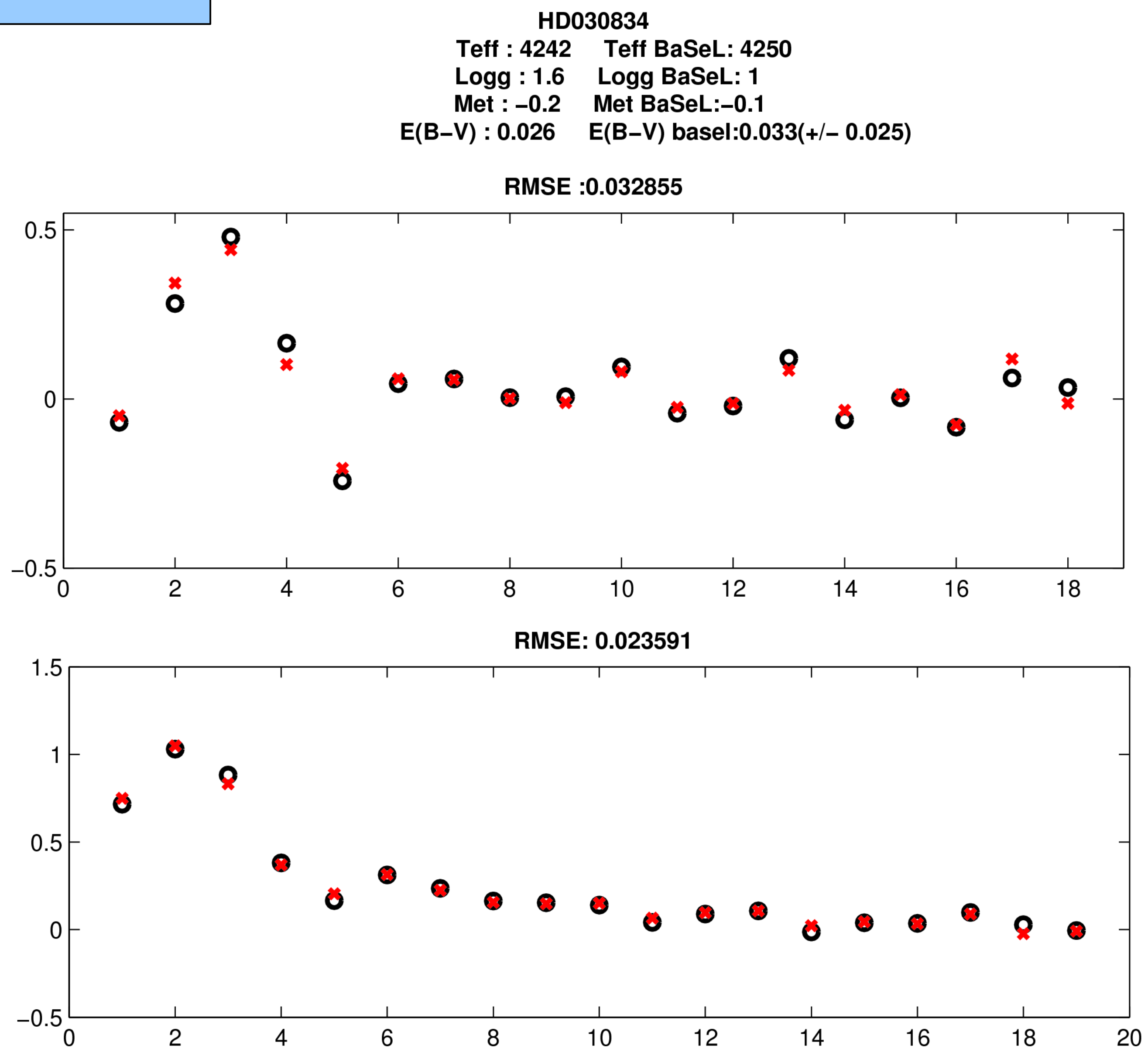
COLD STARS

G SPECTRAL TYPE



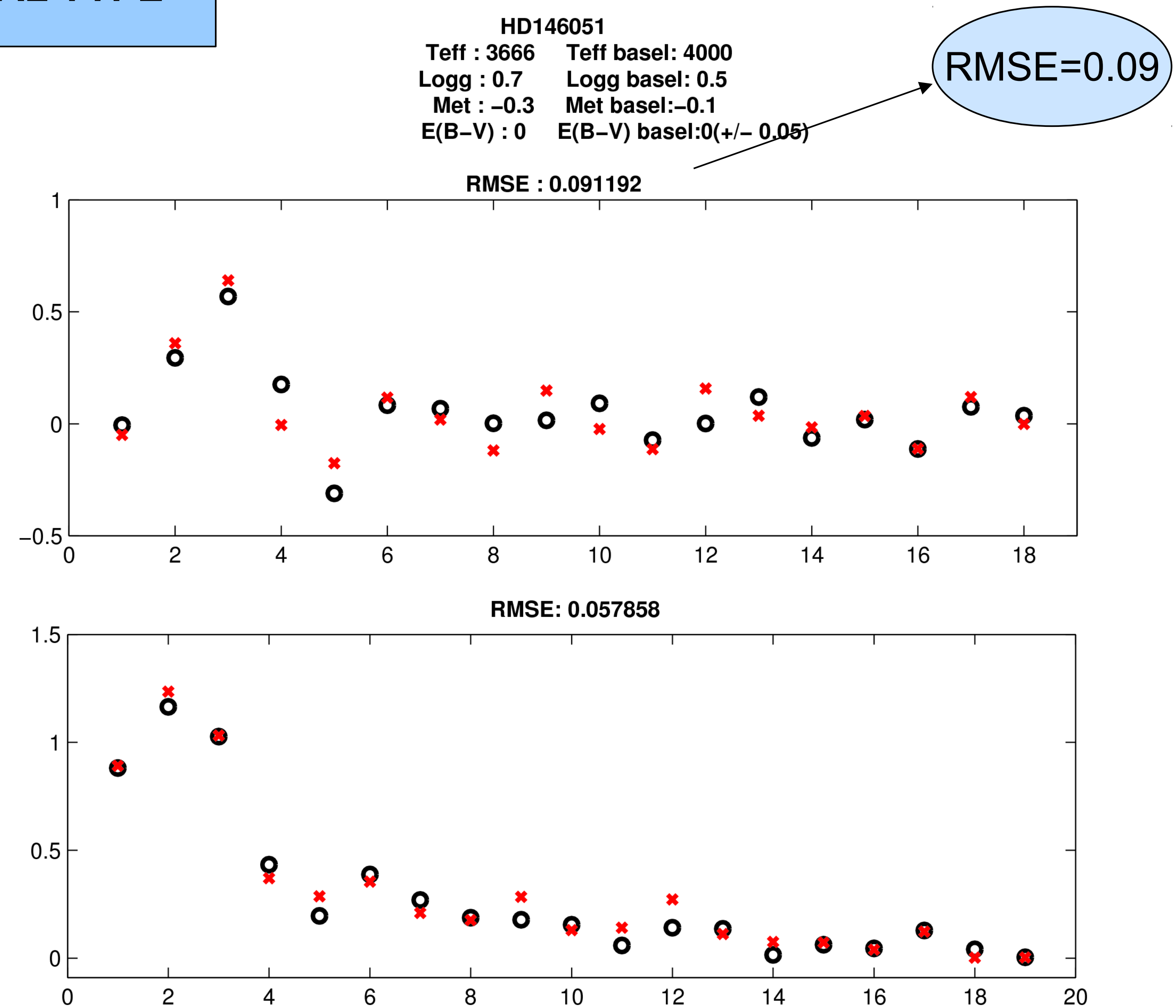
COLD STARS

K SPECTRAL TYPE



COLD STARS

M SPECTRAL TYPE



THANKS-MERCI-GRACIAS!!