Characteristics of Variable Stars/Objects

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- Zoo (GCVS, HR diagram, examples: ACVn, GDOR, Be)
- Past/Ongoing data: Microlensing surveys, Hipp, ASAS, ...
- Near-Future Sources: MOST, COROT, exoplanet searches, ...
- Future: large scale surveys (POI, LSST)
- Estimations of variable stars detected by GAIA
- Email asking for compilation and responses
- Work to do

General Goal

- Study known classes
- compile their properties
- transform into GAIA properties (filter system + RV)

Why?

- Forecast number of detected variable objects
- Design an efficient variable star analysis software
- Extract specific variables
- Distinguish "unknown" versus "known" (general classification)

This should be studied in parallel with software development

The GCVS (General Catalogue of Variable Stars)

http://www.sai.msu.su/groups/cluster/gcvs/gcvs/iii/vartype.txt

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GCVS Variability Types

and

Distribution Statistics of Designated Variable Stars

According to their Types of Variability

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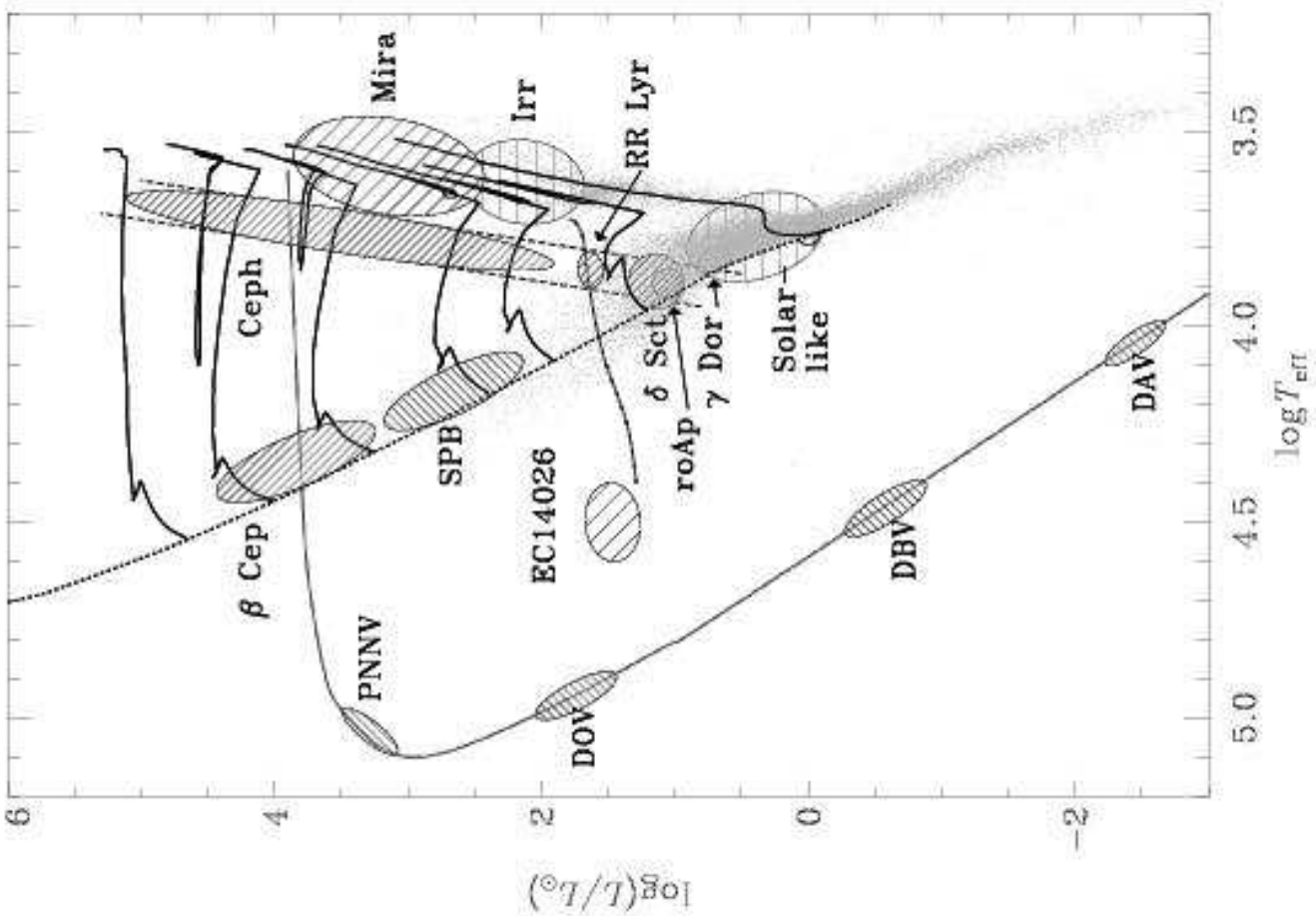
I. GCVS Variability Types

An improved system of variability classification is used in the fourth edition of the GCVS, based on recent developments in classification principles and taking into account the suggestions of a number of specialists. Variability types are grouped according to the major astrophysical reasons for variability, viz.,

1. eruptive (FU, GCAS, I, IA, IB, IN, INA, INB, INT, IT, IN(YY), IS, ISA, ISB, RCB, RS, SDOR, UV, UVN, WR),
2. pulsating (ACYG, BCEP, BCEPS, CEP, CEP(B), CW, CWA, CWB, DCEP, DCEPS, DSCT, DSCTC, L, LB, LC, M, PVTEL, RR, RR(B), RRAB, RRC, RV, RVA, RVB, SR, SRA, SRB, SRC, SRD, SXPHE, ZZ, ZZA, ZZB),
3. rotating (ACV, ACVO, BY, ELL, FKCOM, PSR, SXARI),
4. cataclysmic (explosive and novalike) variables (N, NA, NB, NC, NL, NR, SN, SNI, SNII, UG, UGSS, UGSU, UGZ, ZAND),
5. eclipsing binary systems (E, EA, EB, EW, GS, PN, RS, WD, WR, AR, D, DM, DS, DW, K, KE, KW, SD),
6. intense variable X-ray sources (X, XB, XF, XI, XJ, XND, XNG, XP, XPR, XPRM, XM),
7. other symbols (BLLAC, CST, GAL, L:, QSO, S, *, +).

HR-diagram: Pulsating stars (some classes not in GCVS!)



GAIA: Forecast of variable star number

http://obswww.unige.ch/~eyer/objexp.html

Example 1: γ Dor stars

Non radial, multiperiodic g-mode oscillations, amplitude: below 0.1 V-mag, periods 0.5-4 days.

Hipparcos appears sub-optimal for this type of stars:

- Hip. sparse sampling / irregular behaviour of γ Dor stars
- Hip. photometric precision / "small" amplitudes of γ Dor stars
- one broad band *Hp* / amplitude larger in B

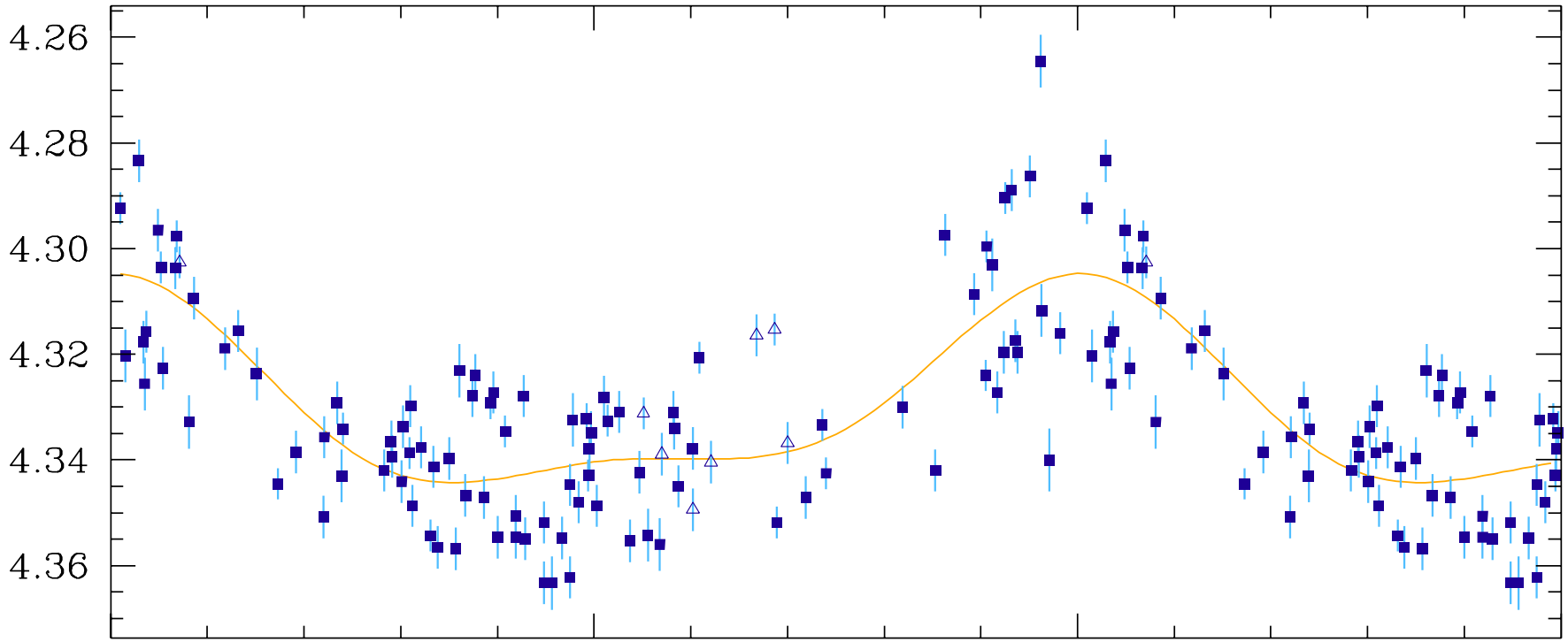
Cousins 1989, 1992, 1994. Several studies on Hipparcos data (PhD Thesis "1997", Aerts et al. 1998, Handler 1999)

Impressive growth of candidates mostly thanks to Hipparcos: from 17 (1995) to 144 (2001)

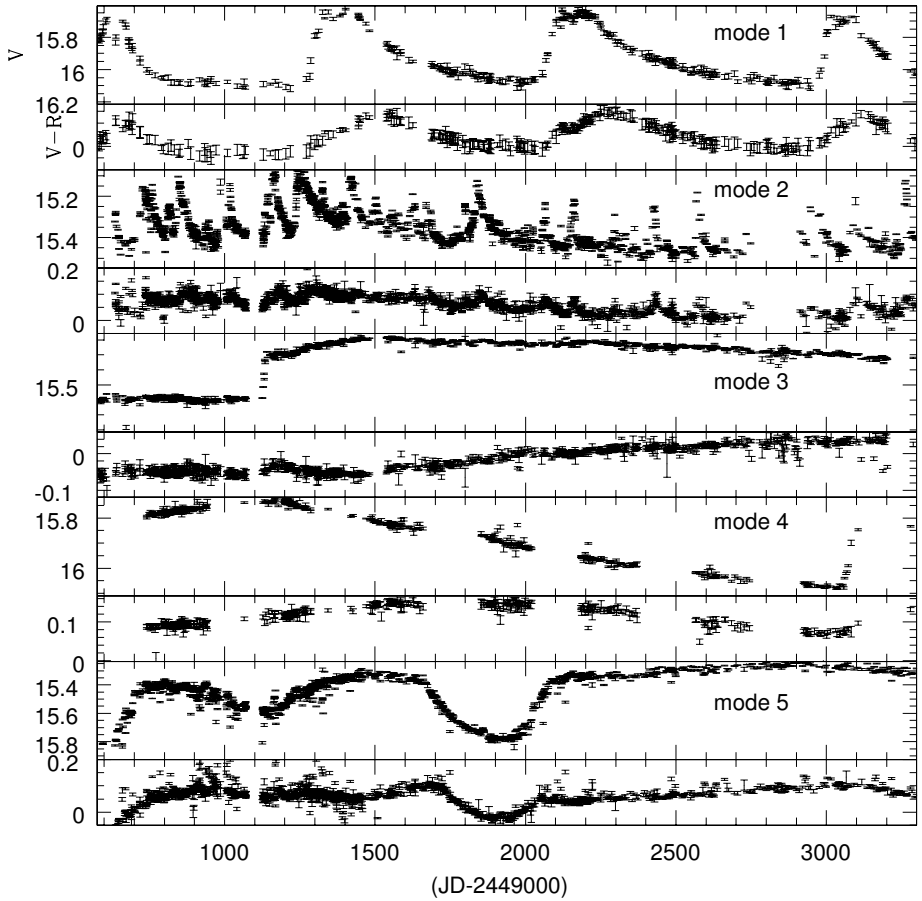
Hipparcos did a significant contribution to the subject (similar for SPBs)

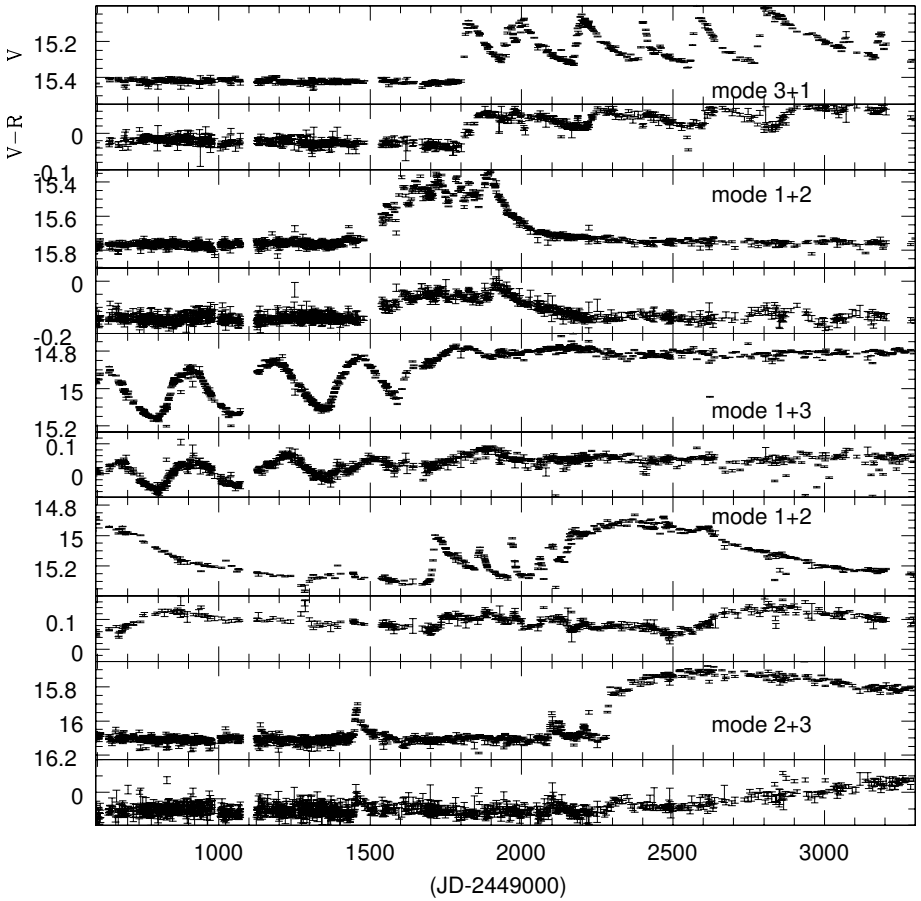
Example 1: γ Dor star light curve

HIP 19893, Period=3.4 days



Example 2: Be stars(a large diversity, MACHO data)





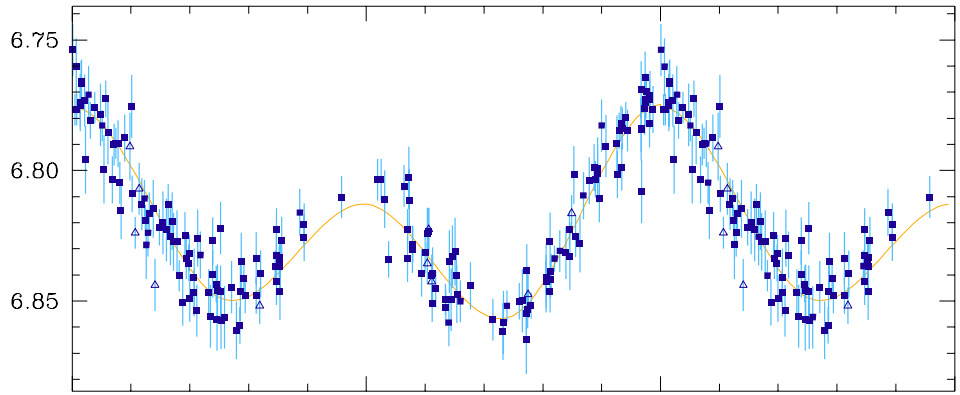
Example 3: α CVn and Hipparcos

Ap stars may have spots on their surface + rotation $\rightarrow$ variability

- Variation can have negative correlation in different filters (for cool Ap stars). Blocking effect in "blue", backwarming in "red"

Cancelation in large band like Hp band

About 50% known variable Ap stars weren't detected by Hipparcos!



HIP 70346, Period=6.8 days

Compilation: Available Sources

- GCVS, Sterken & Jashek (both heterogeneous)
- `http://obswww.unige.ch/~eyer/surveys.html`
- Geneva photometry ("simultaneous" multibands), selected targets

Compilation: small amplitudes

- MOST CSA (Canada), 2003
- COROT CNES (France)/ESA, 2006
- Kepler NASA, 2007

Email and responses

I asked the members of the working group to give a summary of their favorite objects and got the following answers:

- SPBs (C.Neiner, P. De Cat)
- β Cep (C.Neiner, P. De Cat)
- γ Dor (P.Matthias)
- CVs (M.Hernanz)
- Be stars (J. Fabregas)
- R Cor Borealis (P. de Laverny)
- LPVs (P. de Laverny)
- Cepheids (pop I and II) (L. Szabados)

Example: RCB Variables (P. de Laverny)

R Coronae Borealis Variables

General description: Clayton, G.C., 1996, PASP 108, 225

UBVRI photometry in Menzies & Feast, 1997, MNRAS 285, 358 ...

MACHO B&V photometry: Alcock et al., 2001, ApJ 554, 298

UBV+IR photometry in Yudin et al., 2002, A&A 394, 617

Spectra : declines : Skuljan L. & Cottrell, 1999, MNRAS 341, 348 ...

During maximum light:

-period of 40-100 days, amplitudes of a few tenths of a magnitude

-spectrum of a F or G supergiant

-radial velocity variations of 10-40 km/s

Brightness declines:

-up to 8 mag. in visible light in a few weeks, occur every few years, remain faint for a large period, rise back to maximum in several months

Work to do

- To be more complete in variable types (extend it to non stellar sources)
- To give a common structure to the variable characteristic database
- To convert those properties into GAIA filters
- To provide template light curves (for test purpose and for the Universe model)
- To get informed with other projects (for small amplitude variable stars, and large scale surveys)