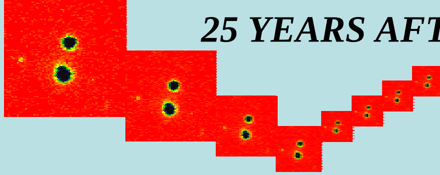

Multi-wavelength and multi-epoch imaging of J1131-1231

A flux ratio anomaly ?

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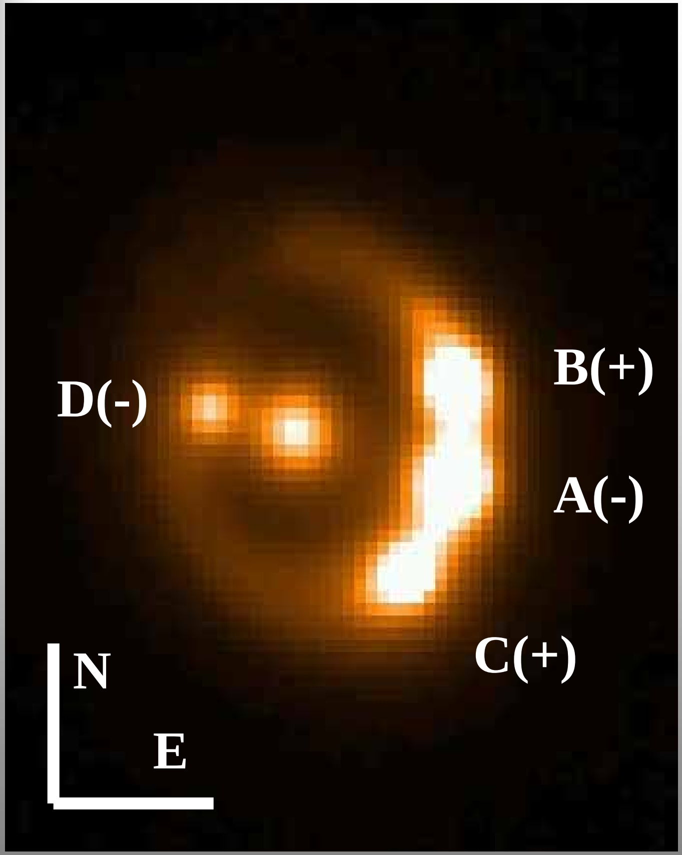
(IAG Liège)

Introduction



- Discovered in 2002 (Sluse et al. 2003)
- Long axis quad.
- Source : $z_s = 0.658$
- Lens : $z_l = 0.295$

Elliptical galaxy

- Cusp configuration systems are systems for which flux ratio anomaly may be easily identified : « magnification sum rule » (Schneider & Weiss 1992)

Introduction

$$\mathrm{R}_{\mathrm{cusp}} = \frac{|\mu_A + \mu_B + \mu_C|}{|\mu_A| + |\mu_B| + |\mu_C|} = \frac{|1 - I_B / I_A - I_C / I_A|}{1 + I_B / I_A + I_C / I_A}$$

For J1131-1231, $\mathrm{R}_{\mathrm{cusp}}$(discovery) ~ 0.36 while $\mathrm{R}_{\mathrm{cusp}}$(SIS+shear) ~ 0.065.

Although $\mathrm{R}_{\mathrm{cusp}}$ may deviate from 0, it seems that it is not possible to construct realistic smooth lens models of J1131-1231 with $\mathrm{R}_{\mathrm{cusp}}$ as large as 0.36 (Keeton et al., 2003; see also Amara et al., 2004).

Should we invoke micro or milli-lensing ?

Introduction

Follow-up observations of J1131-1231 to disentangle between those two scenarii …

i)Improve the relative astrometry.

ii)Study the time flux variation (micro-lensing, intrinsic variability).

iii)Investigate the chromatic flux variations.

The data

Date	Epoch	Instrument	Filtre
21 Nov 2002	1	SOFI	J
12 Avr 2003	2	ISAAC	Ks
21 Avr 2003	3	FORS2	Rspec
02 May 2003	4	FORS2	Rspec
26 May 2003	5	FORS2	B
17 Jun 2003	6	FORS2	V, Rspec
17 Nov 2003	7	FORS2,NIC2	B, V, R, F160W
09 Feb 2003	8	CFHT-IR	J, H, K’
12 Avr 2004	9	FORS1	B, V, R, I

i) Relative astrometry

- New data : NICMOS + FORS + ISAAC
- Relative astrometry deduced from the MCS (Magain, Courbin, Sohy 1998) deconvolution / gaussian fit.
- All the relative positions (obtained with typically 5 mas accuracy) agree within less than 10 mas on all the data sets.

i) Relative astrometry

Improved smooth lens models (SIS+shear, EIS; EIS+γ) : lens parameters not very different from the discovery (however C leading)

Expected flux ratios (EIS+γ) and observed ones (*discovery paper*; Sluse et al 2003)

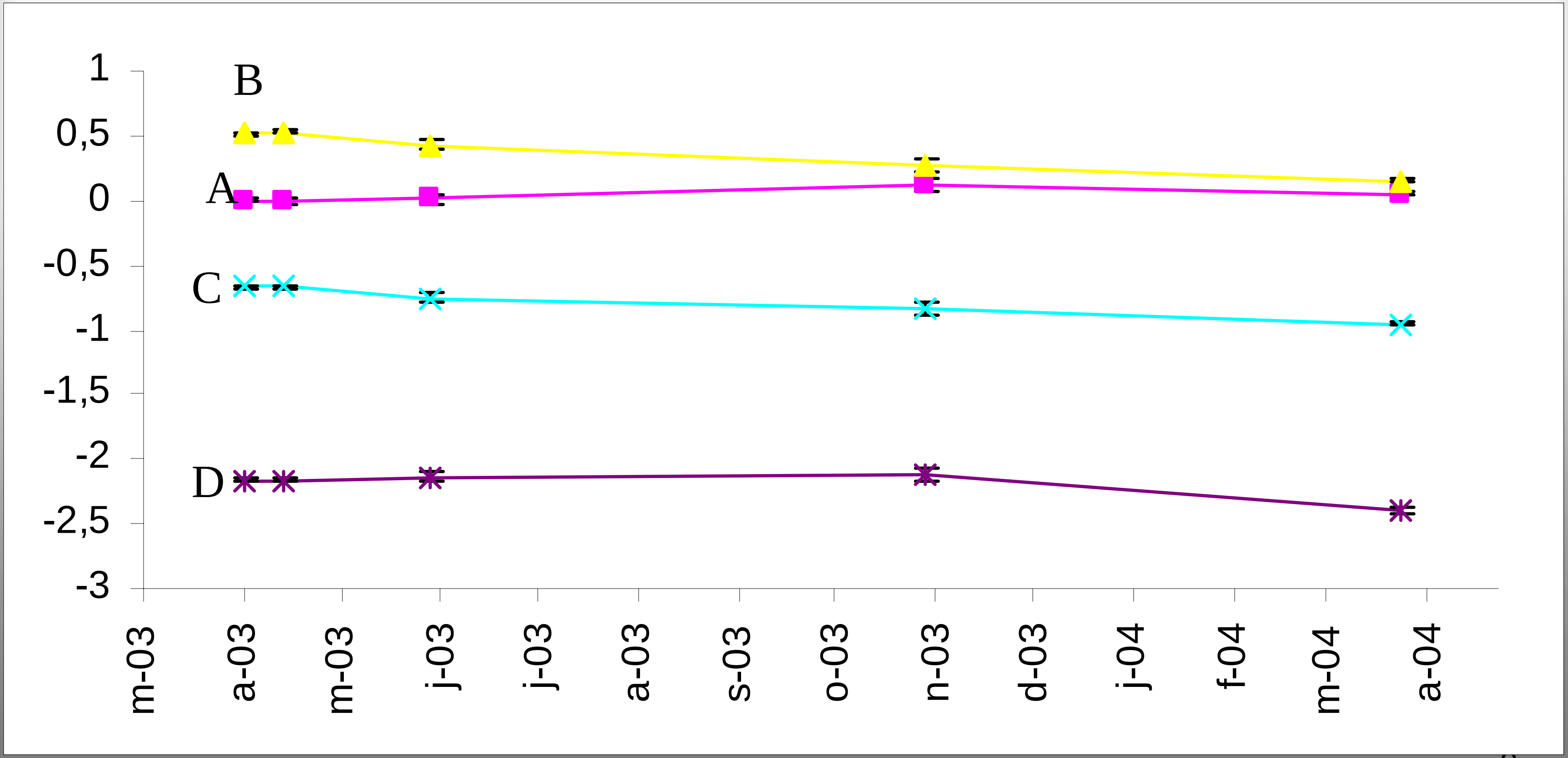
	Δm_{AB}	Δm_{AC}	Δm_{AD}	Δm_{BC}	R_{cusp}
Model	-0.54	-0.65	-3.2	-0.11	0.07
Observed	+0.46	-0.62	-2.2	-1.1	0.36

ii) Time flux variations

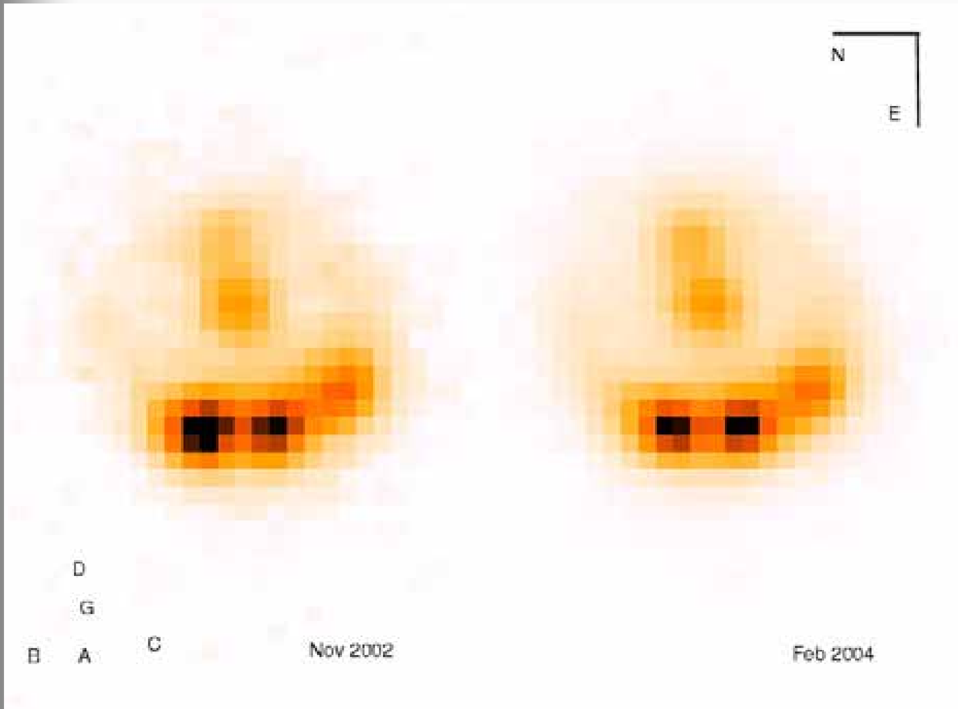
- Photometry = output of the MCS (Magain, Courbin, Sohy 1998) deconvolution (same ring at all epochs).
- R band FORS1 and FORS2 images.
- 5 epochs (April 2003 -> April 2004)

ii) Time flux variations

R band



ii) Time flux variations



•*Scenario* ***S1*** :

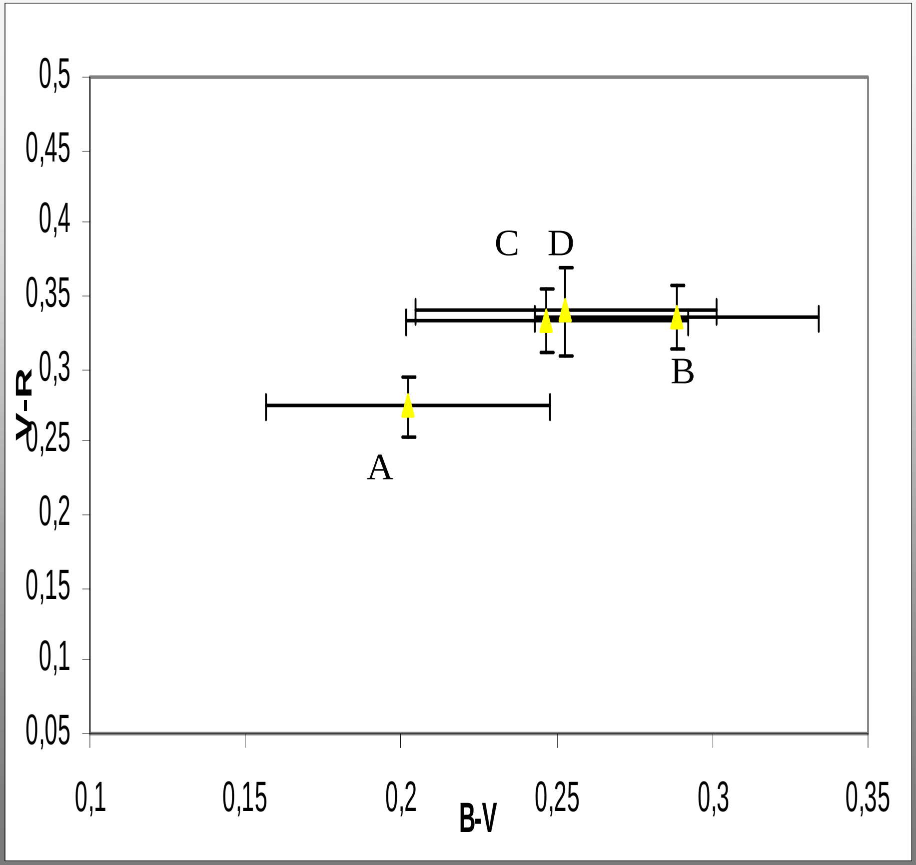
A is micro-lensed (end of a de-amplification or begining of an amplification)

•*Scenario* ***S2*** :

B *&* **C** are micro-lensed (end of an amplification or begining of a de-amplification)

iii) Chromatic variations

a) Differential extinction

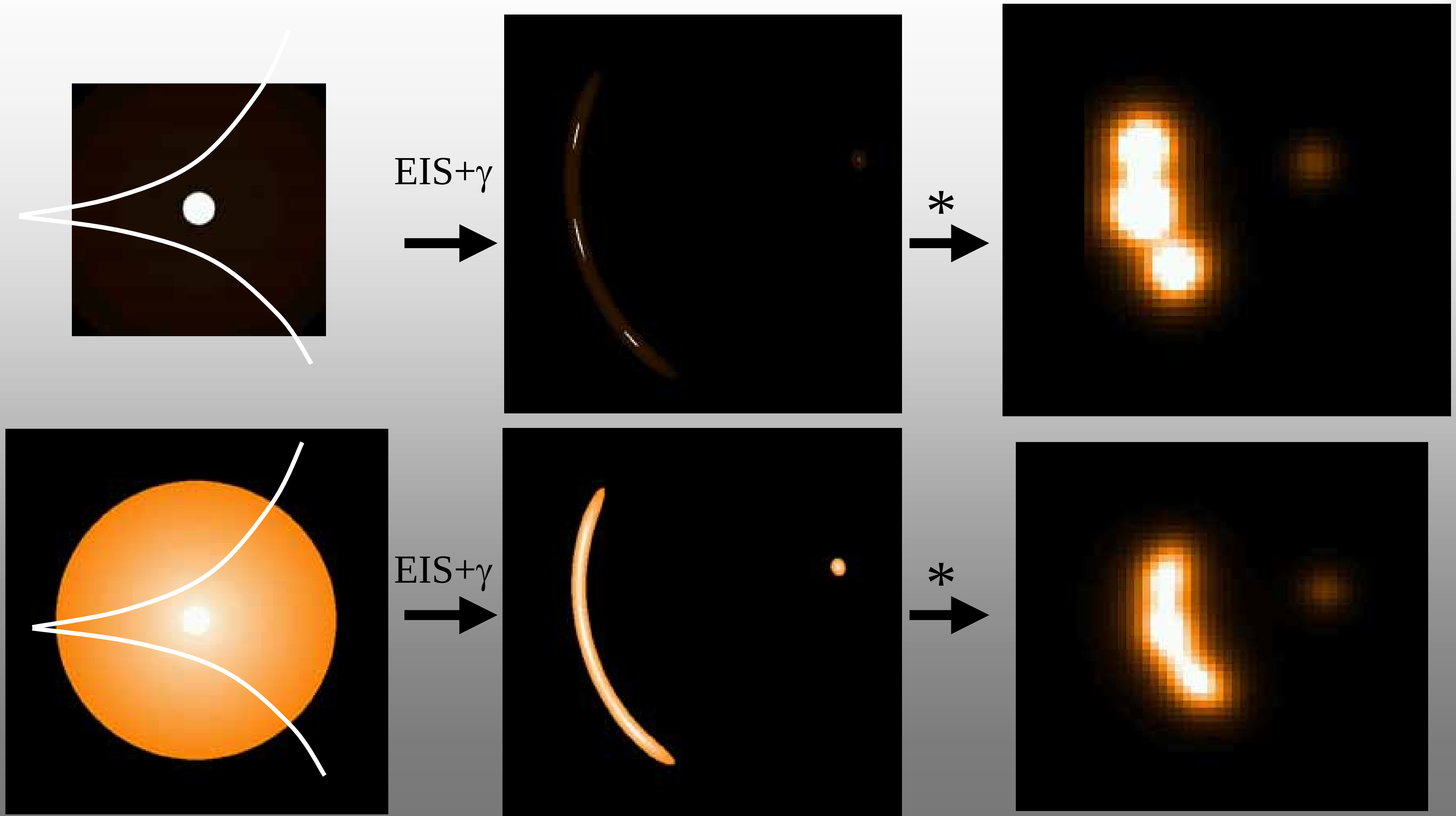


B-V-R colors in April 2004

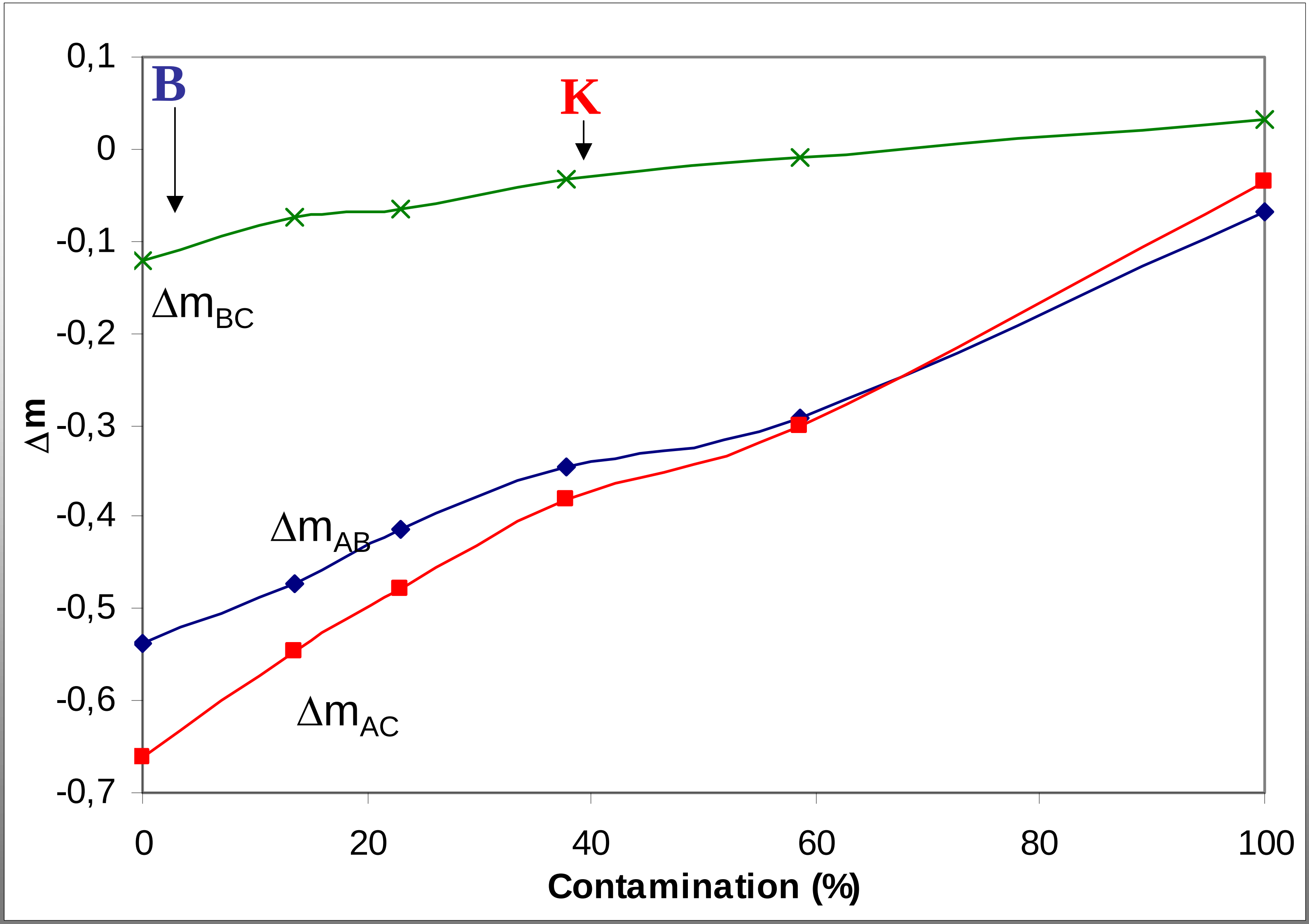
Idem in November 2004

iii) Chromatic flux variations

b) Ring contamination + differential amplification : schematic view



iii) Chromatic variations



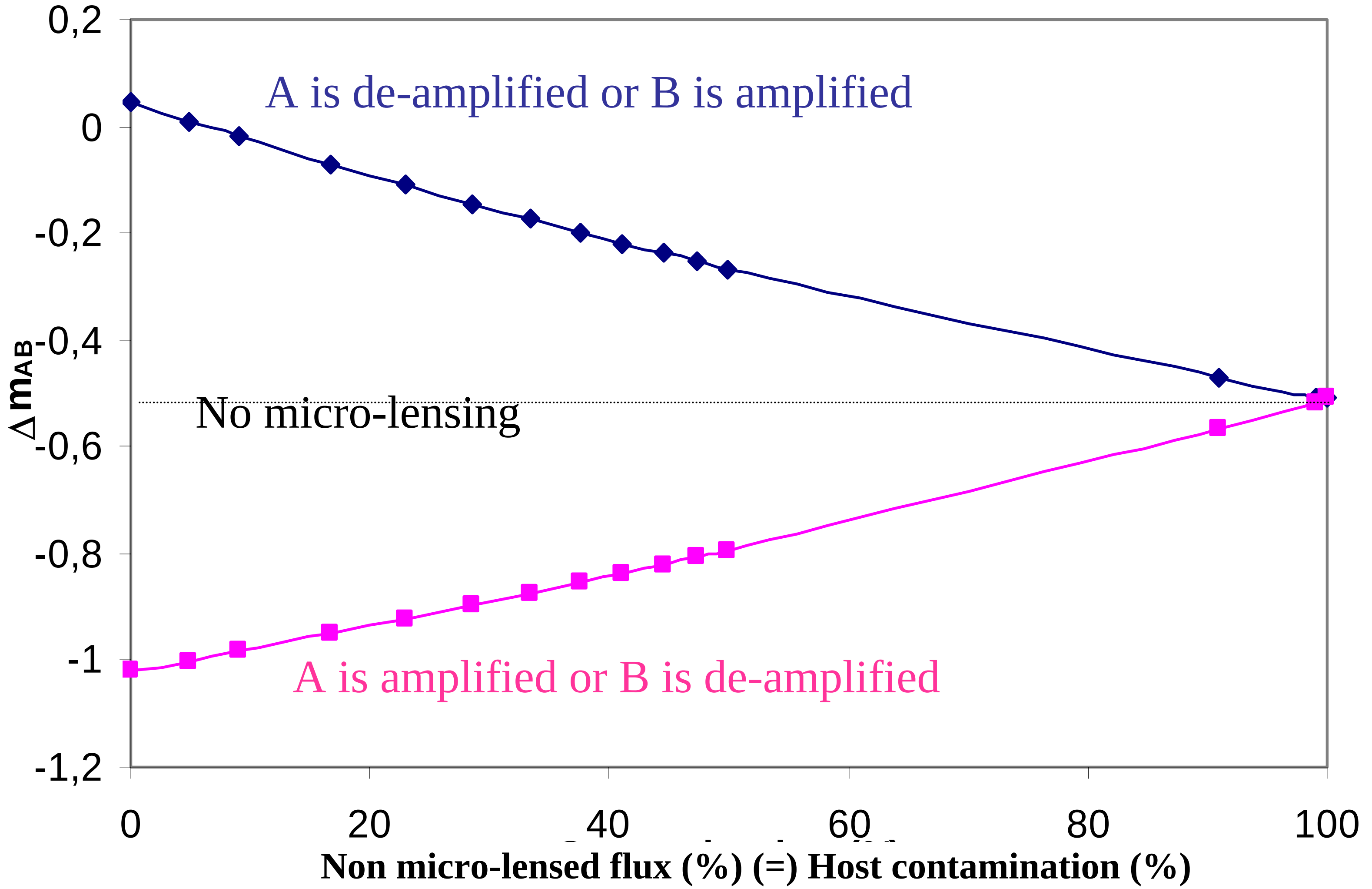
iii) Chromatic variations

c) Micro-lensing

With the increasing ring brightness, the micro-lensed flux (QSO only) will be damped in the total point-like flux (QSO+host).

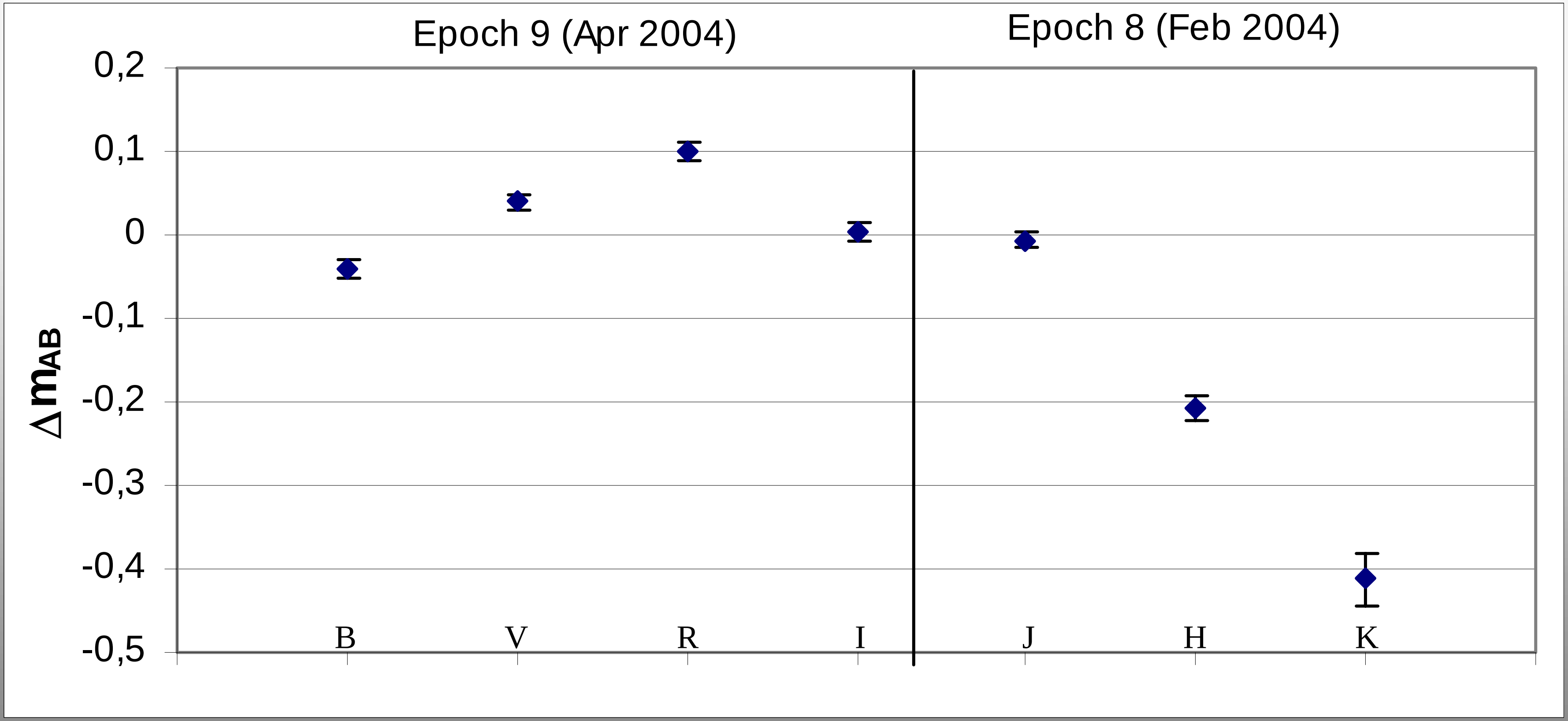
=> Flux ratio will tend towards the *contaminated* macro-lensed flux ratio with the increasing host galaxy contribution (i.e. going from visible to NIR wavelength).

iii) Chromatic variations



iii) Chromatic variations

Observed flux ratios



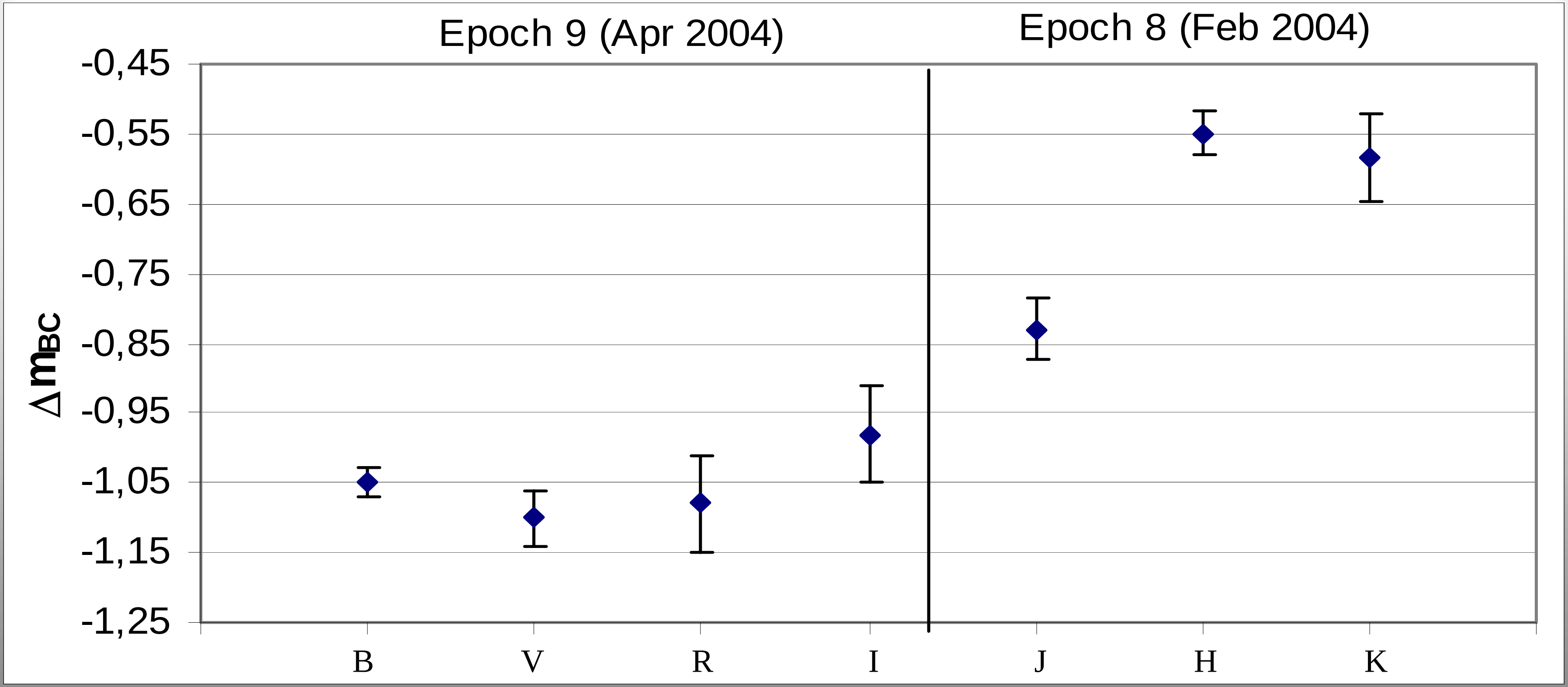
$\Delta m_{AB}(EIS+\gamma)=-0.54$

S1 : A is DE-AMPLIFIED

S2 : B is AMPLIFIED

iii) Chromatic variations

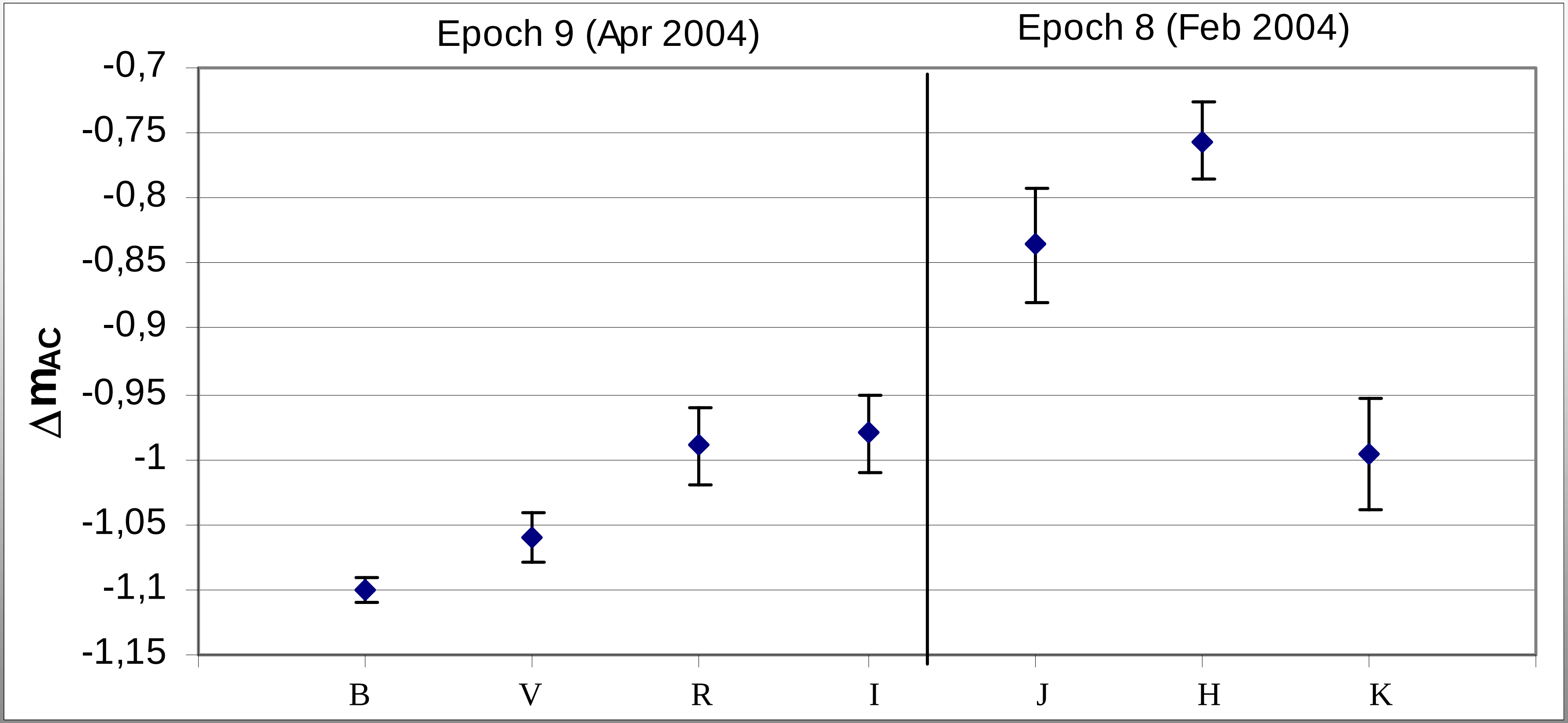
Observed flux ratios



$\Delta m_{BC}(EIS+\gamma)=-0.11$

iii) Chromatic variations

Observed flux ratios



$\Delta m_{AC}(EIS+\gamma)=-0.65$

S1 : A is DE-AMPLIFIED

S2 : C is AMPLIFIED (cf K band)

Summary and conclusions

- Improved astrometry => EIS+γ model reasonably good (Δm_{BC}=-0.11).
- Time flux variations => A is micro-lensed (S1) OR B & C are micro-lensed (S2).
- Chromatic flux variations => A is de-amplified (note that A = saddle point…) OR B & C are amplified.
- Whatever the micro-lensing scenario :

- $|\Delta m_{BC/AC}$ (obs)$|$ >> $|\Delta m_{BC/AC}$ (mod)$|$.
- Chromatic flux variation => R_{cusp} (corrected)$\geq$ 0.025.

Microlensing : YES but flux ratios still deviate from simple model predictions.

More complex models but also substructures ?