The problem of multiperiodicity

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"Q2: Does the science case place any constraints on the tradeoff between uniformity of sampling and frequency of sampling? For example, a rolling cadence can provide enhanced sample rates over a part of the survey or the entire survey for a designated time at the cost of reduced sample rate the rest of the time (while maintaining the nominal total visit counts).

A2: **An enhanced cadence could provide earlier discovery and period confirmation for a subset of targets, but this is not a high priority.**"

(LSST Observing Strategies White Paper)

"What cadence is required for "accurate multi-wavelength Fourier decomposition"? **Cepheids and RR Lyraes are strictly periodic.** Then for known variables, whose periods are already known, such Fourier decompositions can be carried out on folded light curves. In such situations given a cadence, one possible measure of the success of this Fourier decomposition could be the maximum phase gap in the folded light curve. Another measure could be the error on the Fourier parameters (Petersen 1986). One way forward is to carry out a detailed Fourier analysis of any one simulated schedule."

(LSST Observing Strategies White Paper)

The above statements oversimplify the situation.

- **Classical Cepheids**
  10%—20% multimodal
- **RR Lyrae stars**
  few % multimodal
  > 50% modulated

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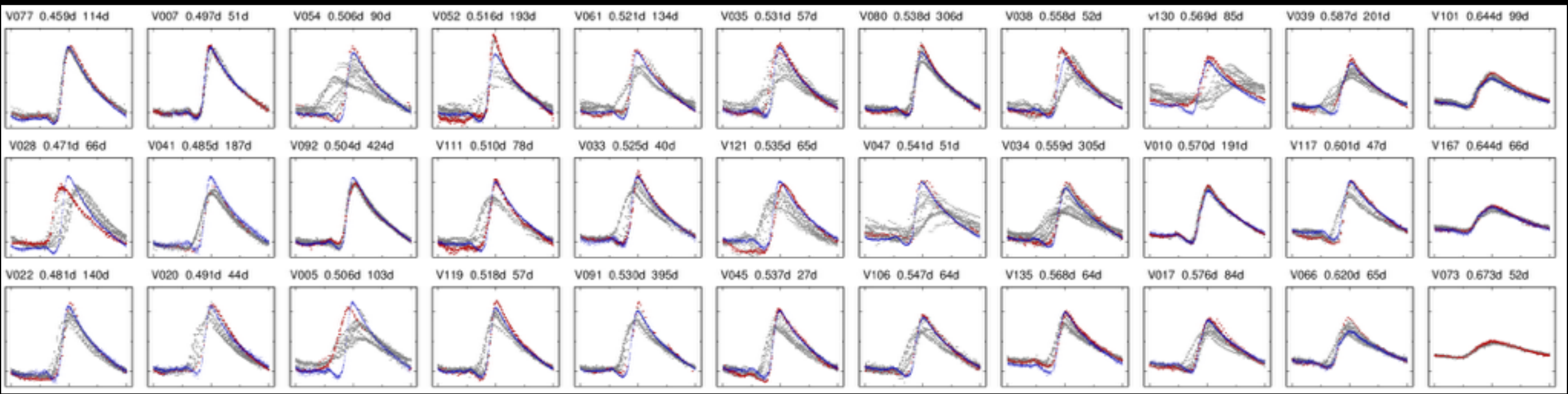
Modulated RR Lyrae stars (*Blazhko effect*) in globular cluster M3:



period increases

grey: all measurements
red: mean model
blue: non-modulated stars with the same properties.

Similarly high occurrence rate of modulation at all periods.

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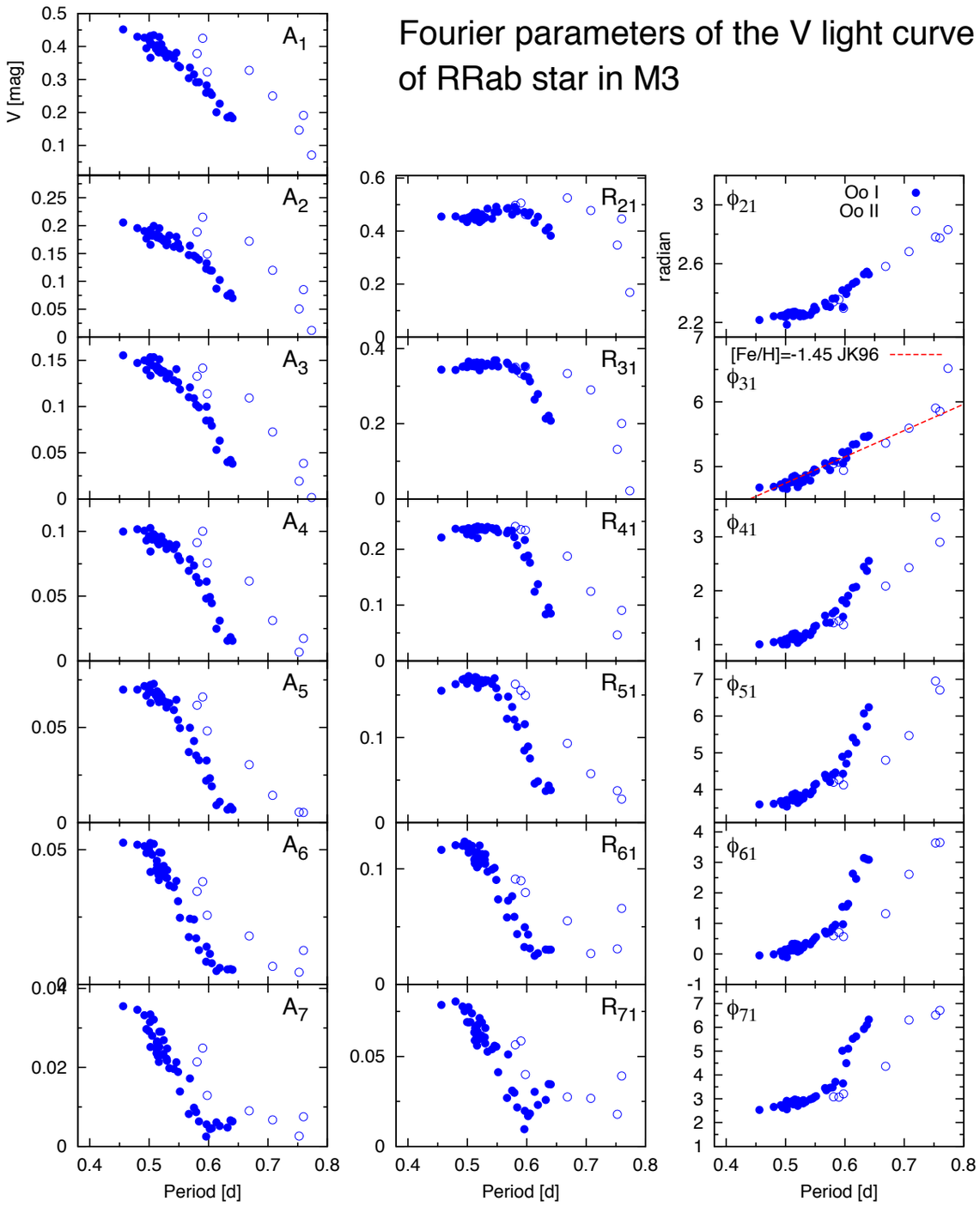

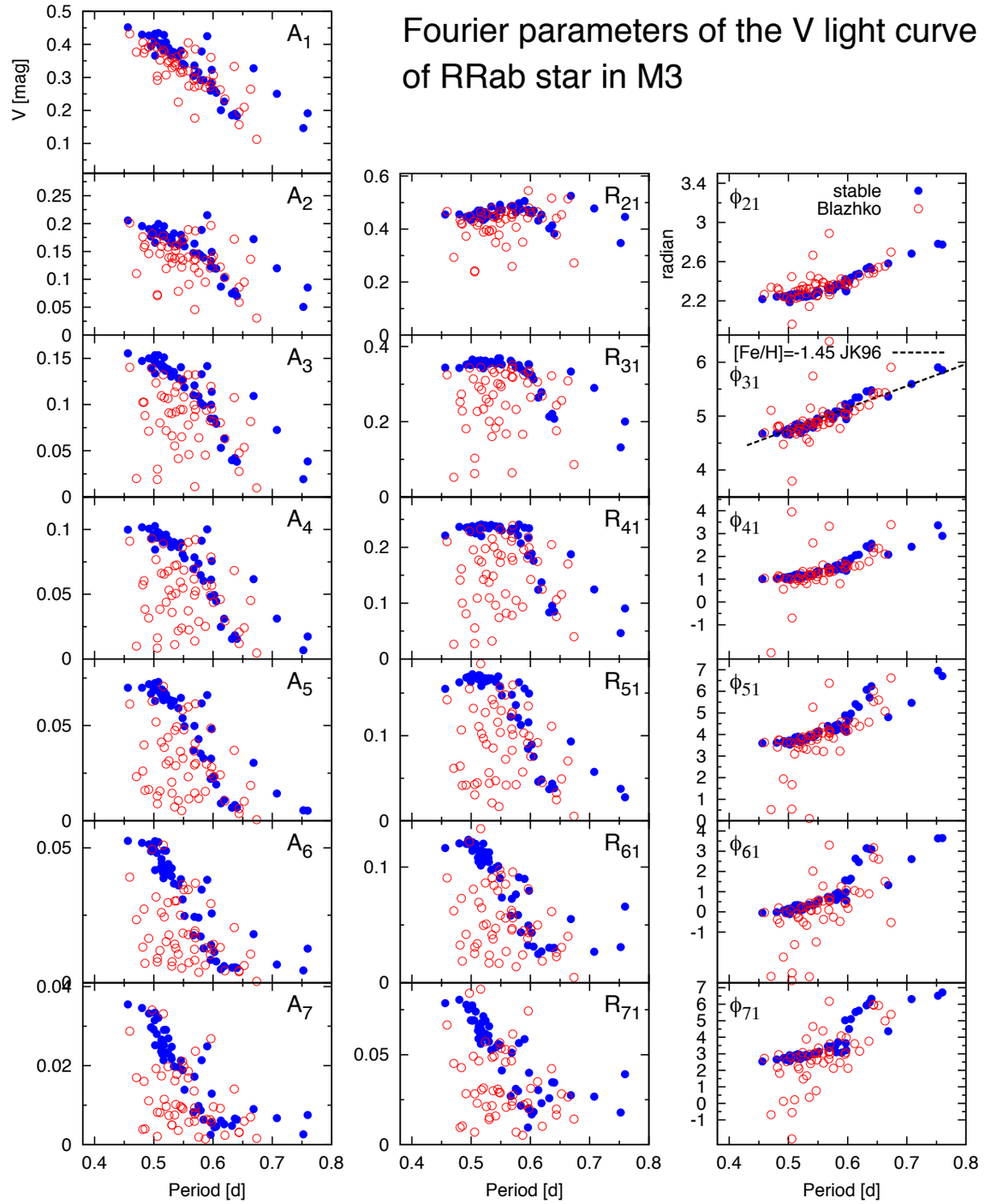

The mean Fourier parameters of modulated stars are systematically different.

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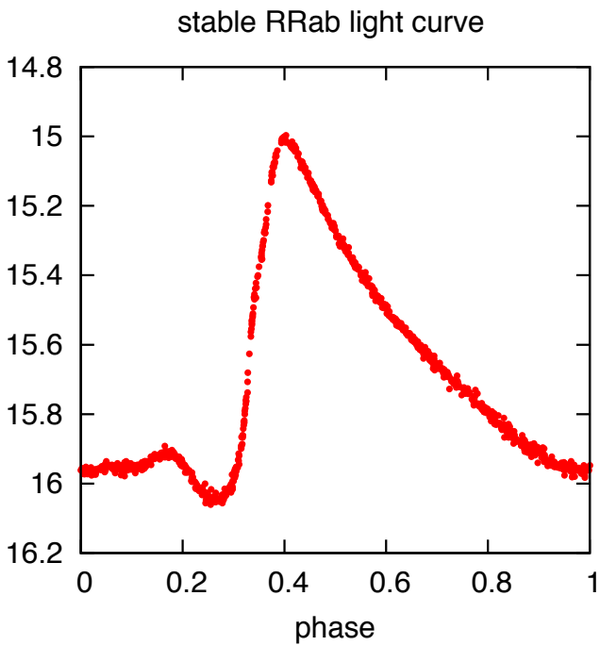
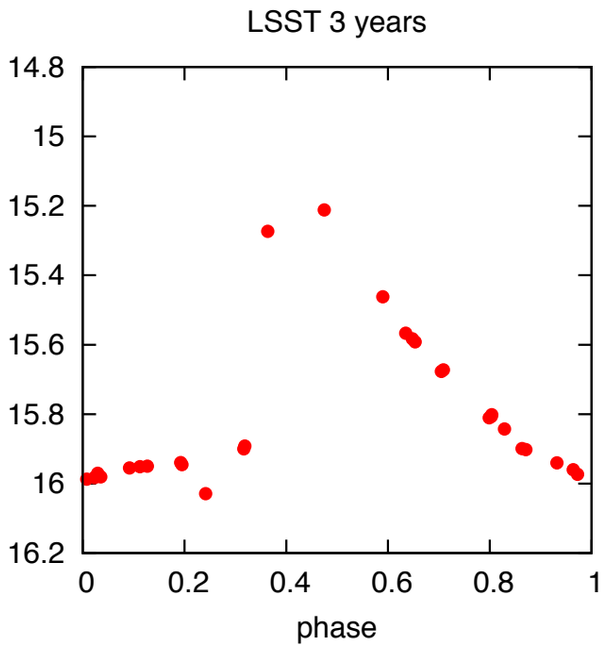
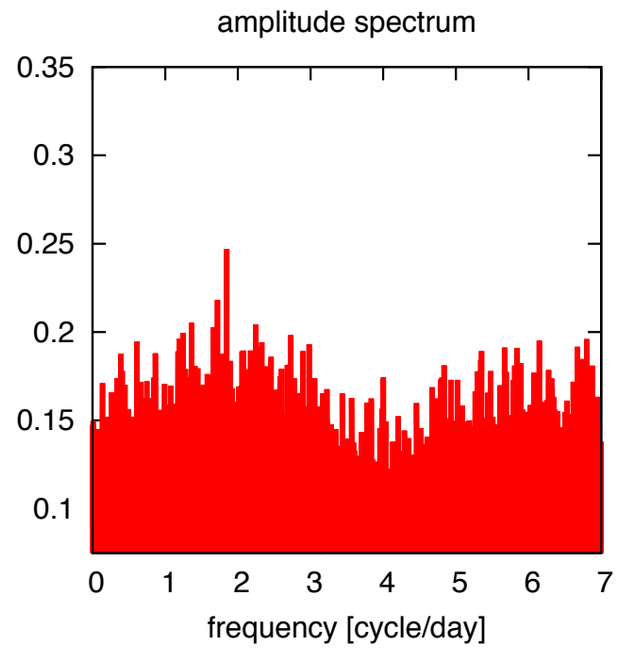
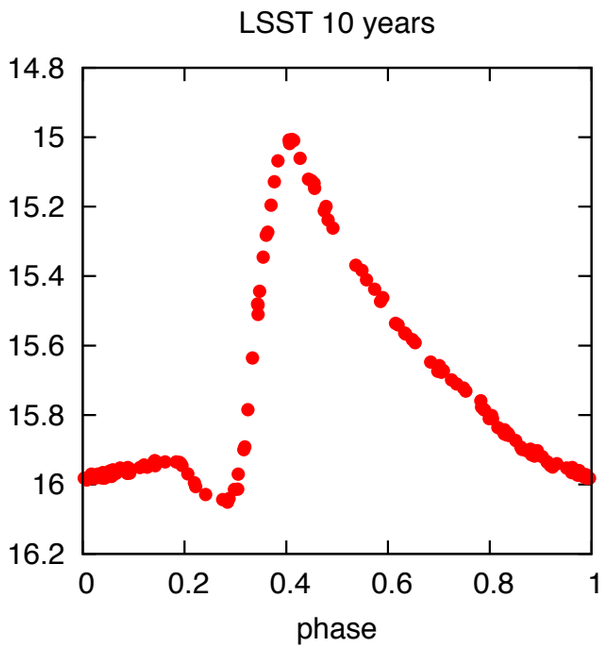
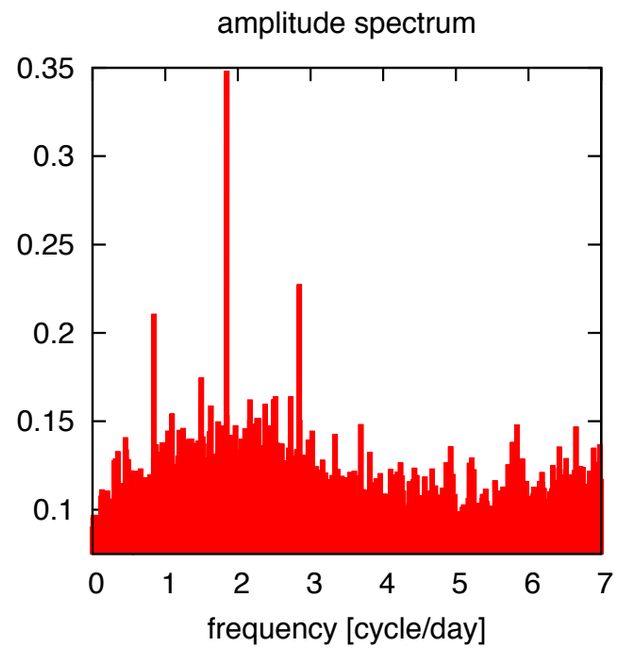






Monoperiodic
RR Lyrae star,
“baseline universal
cadence”-like sampling





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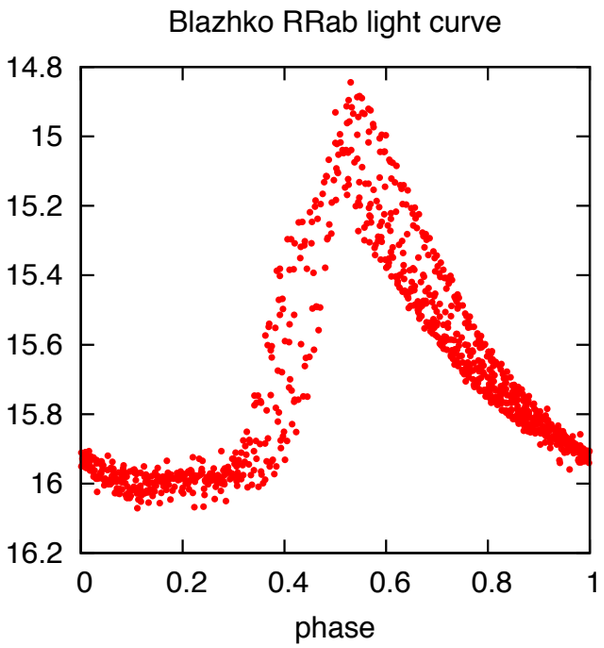
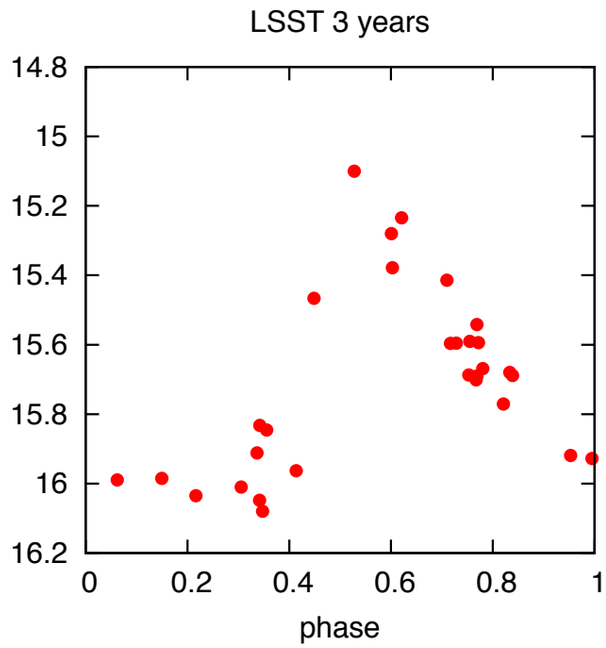
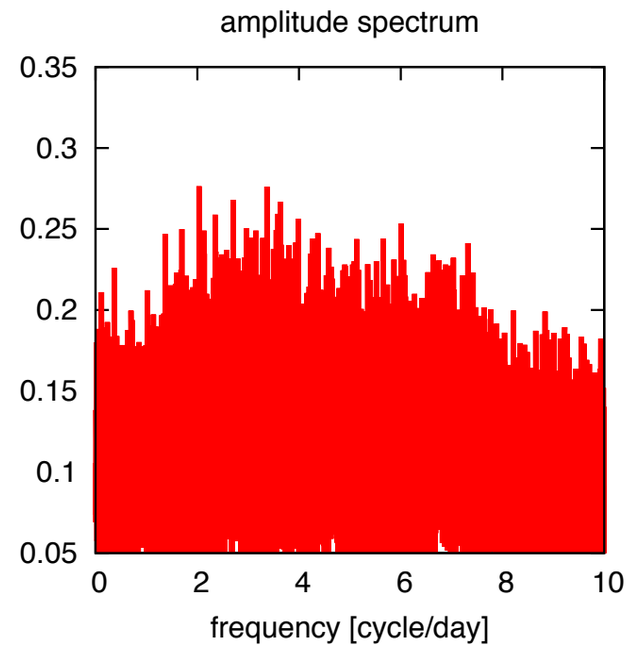
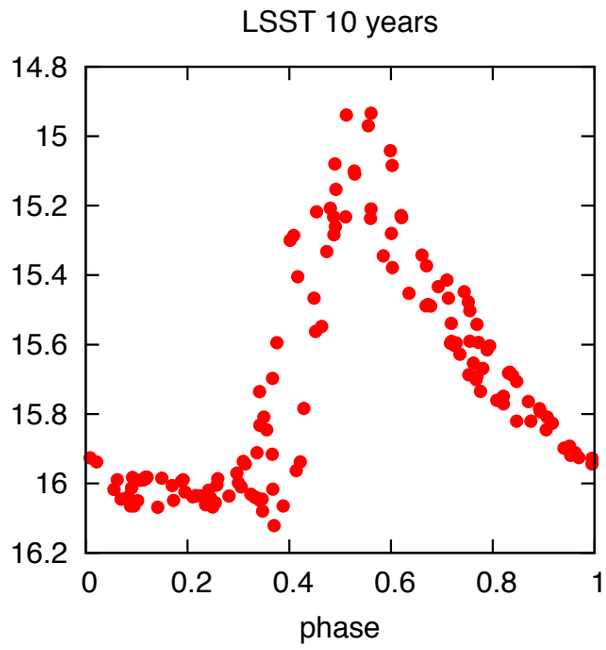
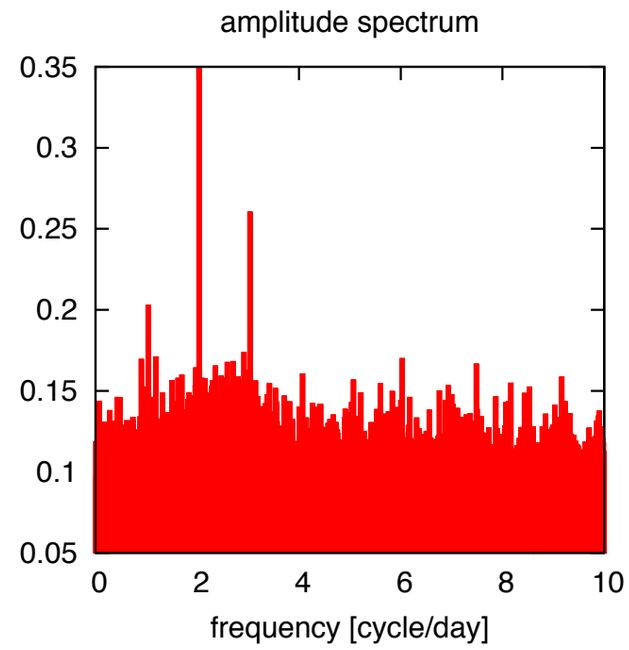






Modulated (Blazhko) RR Lyrae star, “baseline universal cadence”-like sampling





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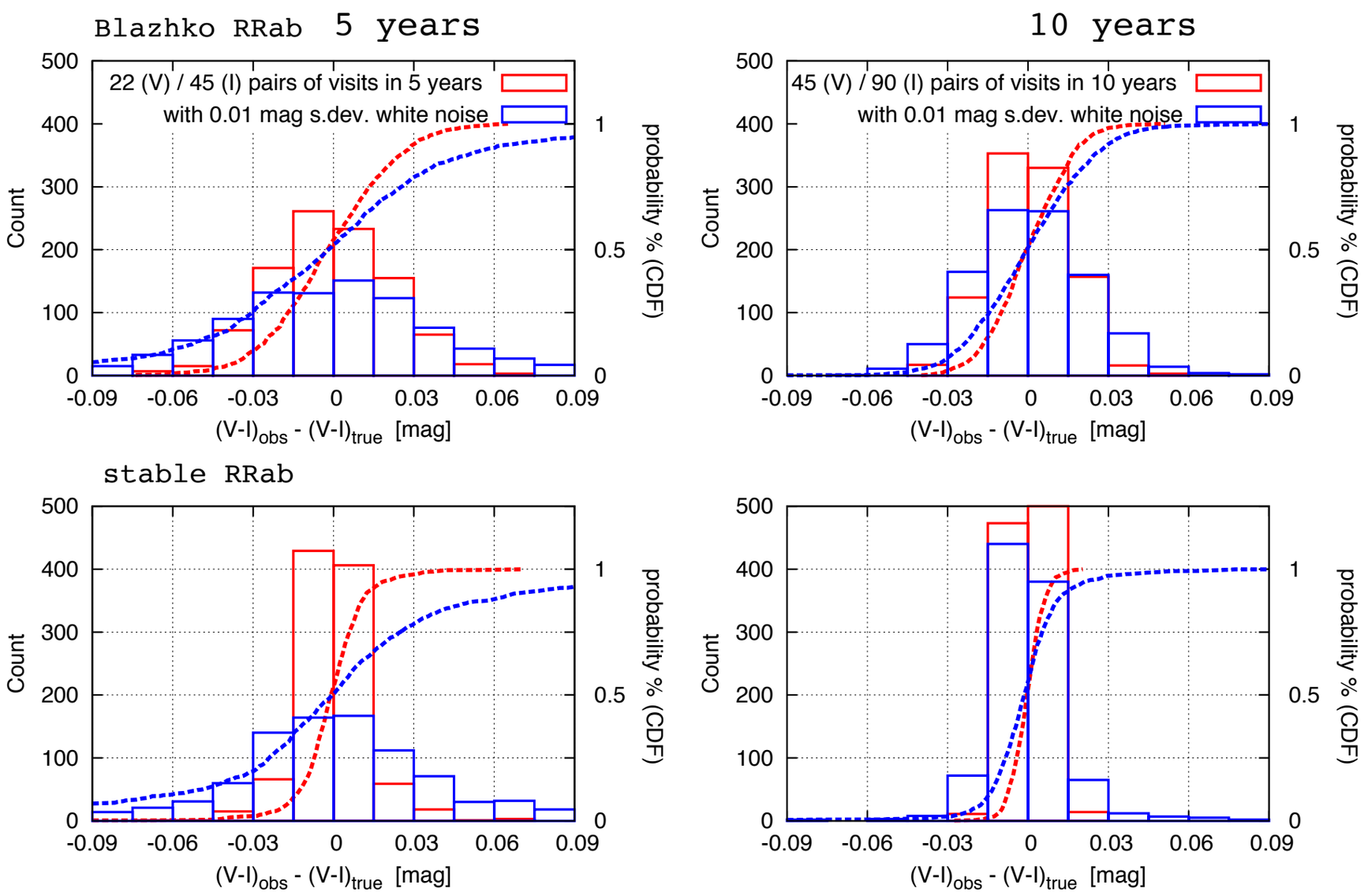
Suboptimal sampling causes *systematic errors in the colour indices.*

Colour indices derived from Fourier model



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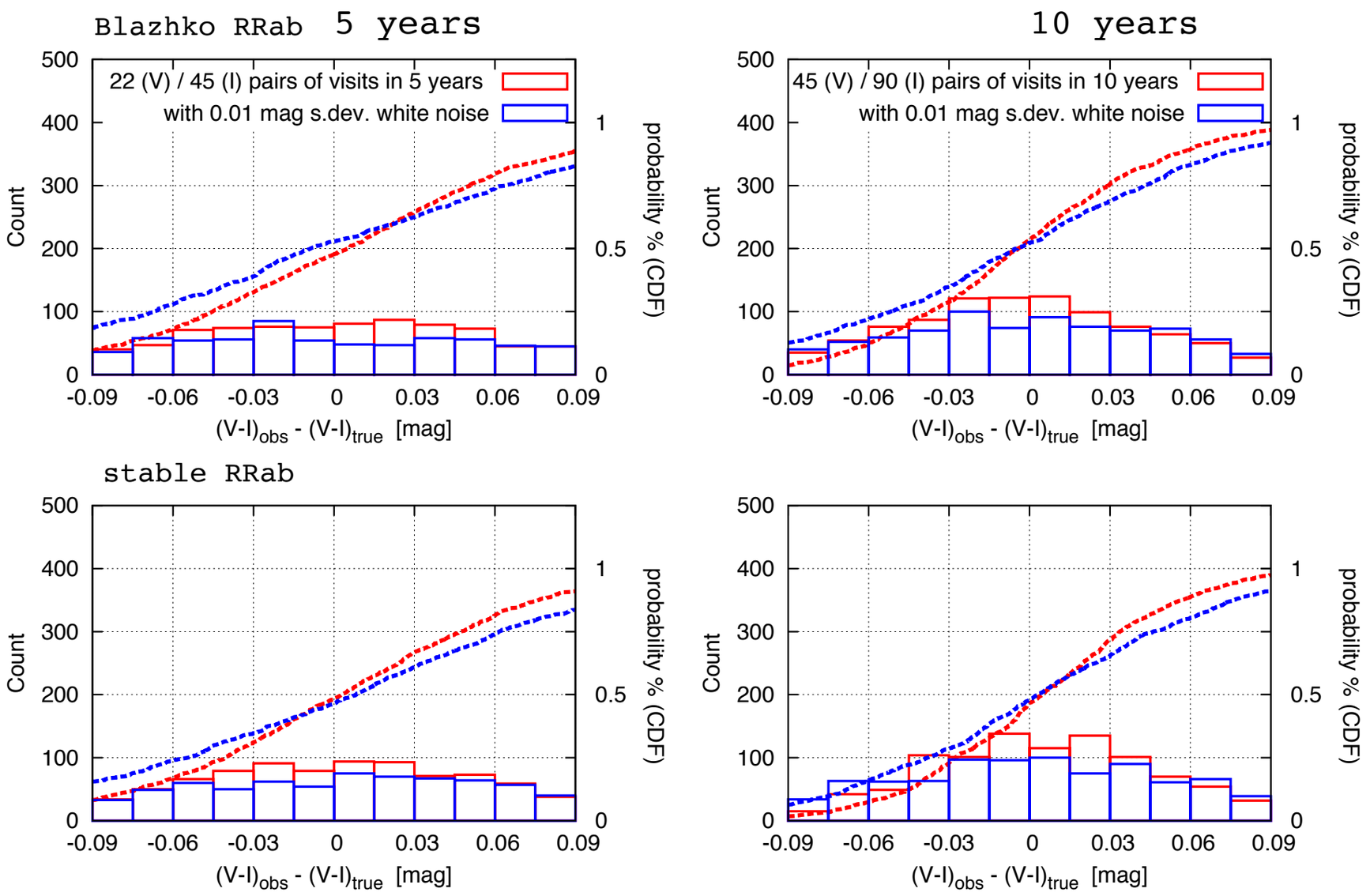
Suboptimal sampling causes *systematic errors in the colour indices.*

Colour indices derived from arithmetic mean of observations



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Summary

- **The “baseline universal cadence” is suboptimal for multi-periodic light curves.**
- Classical pulsators (Cepheids, RR Lyrae stars) are primary targets of LSST.
- **The fraction of multi-periodic classical pulsators is high.**
- **Suggestion:**
  Consider alternative sampling (cadence) as a baseline survey strategy
  Detailed evaluation of rolling cadences is desirable
  Alternative: a (complementary) mini-survey with rolling cadence