KOBEsim

Improving RV detection through efficient scheduling

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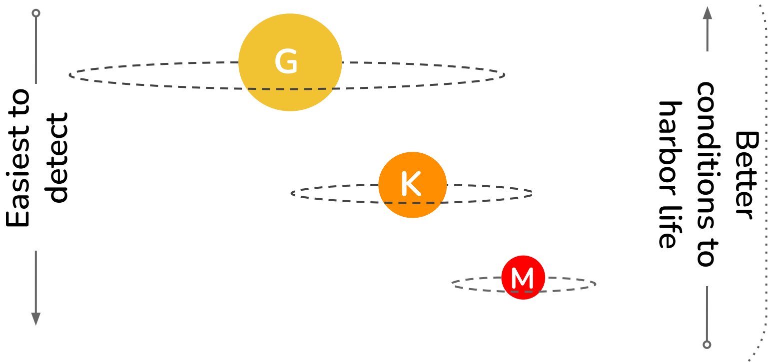
The KOBEsim algorithm is a **Bayesian-based strategy for the detection of planets in radial velocity (RV) surveys** written in Python. It is developed within the KOBE (K-dwarfs Orbited By habitable Exoplanets) experiment, aiming at maximizing the detection of rocky exoplanets potentially habitable orbiting K-dwarfs. After gathering the first data, KOBEsim targets the predominant orbital period and finds the optimum next observing date to maximize the efficiency of confirming or discarding that signal. This new approach has demonstrated to **improve nearly 50 % the detection efficiency** in comparison with a conventional strategy of monotonic cadence.

The KOBE experiment

KOBE (**Lillo-Box et al. 2022**, submitted) is the first exoplanetary hunting devoted to the K-dwarf spectral domain. In spite of being poorly explored to date, they are an excellent astrobiological target. They accomplish a trade-off between G and M stars in terms of detectability-habitability. Furthermore, they are expected to have the greatest occurrence rate within the HZ (**Kunimoto & Matthews 2020,** AJ Volume 159). Since January 2021 this program is monitoring **50 late K-dwarf** stars over **five semesters** with the CARMENES spectrograph (CAHA observatory, Spain).



Efficiency gain

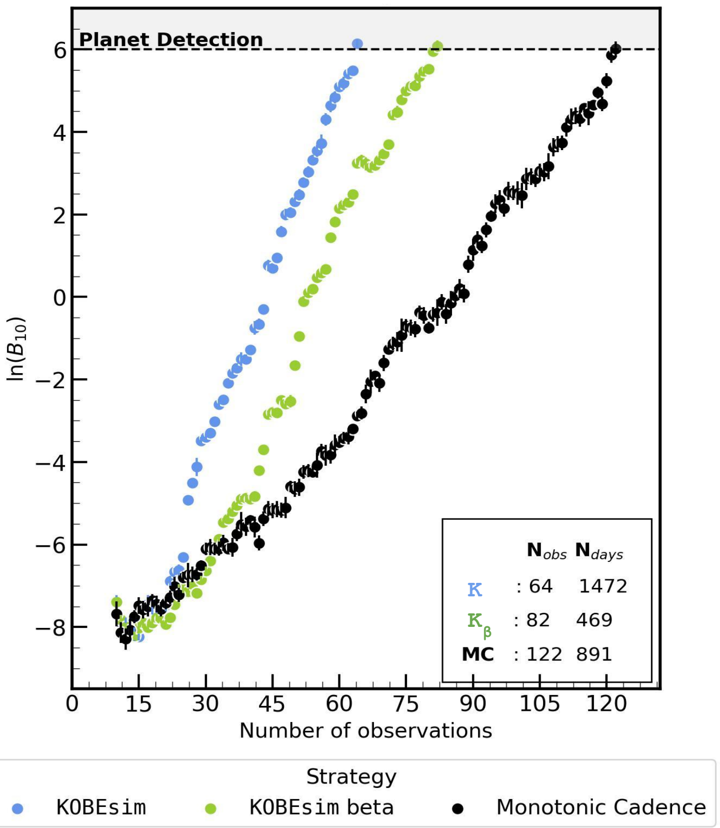
The **Bayes factor** measures how significant one model is compared to the other and intrinsically penalizes the more complex one (Occam's razor). We consider there is a **detection** when the logarithm of the Bayes factor of H_1 over H_0 is higher than 6.

Competing models

H_0: null hypothesis (no planet)
H_1: One-planet model

In the figure on the bottom, we simulate the Bayes factor evolution for 3 different observing approaches: KOBEsim (K), KOBEsim with a beta function to favor observing at close dates (K_β), and a Monotonic Cadence strategy (**MC**). This simulation is for a 5 $M_\oplus$ planet with a 59-days orbital period inducing a RV-semiamplitude of 1.16 m s^{-1}.

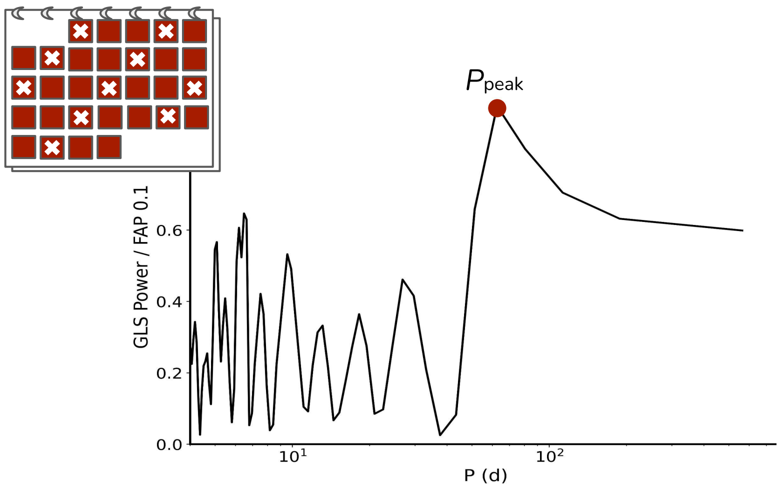
The K strategy improves in 48 % the number of observations needed in comparison with **MC**. Nonetheless, to find a trade-off with the timespan is necessary to use K_β. This approach **speeds up the detection 33 %** in terms of observations and **47 %** in number of days.



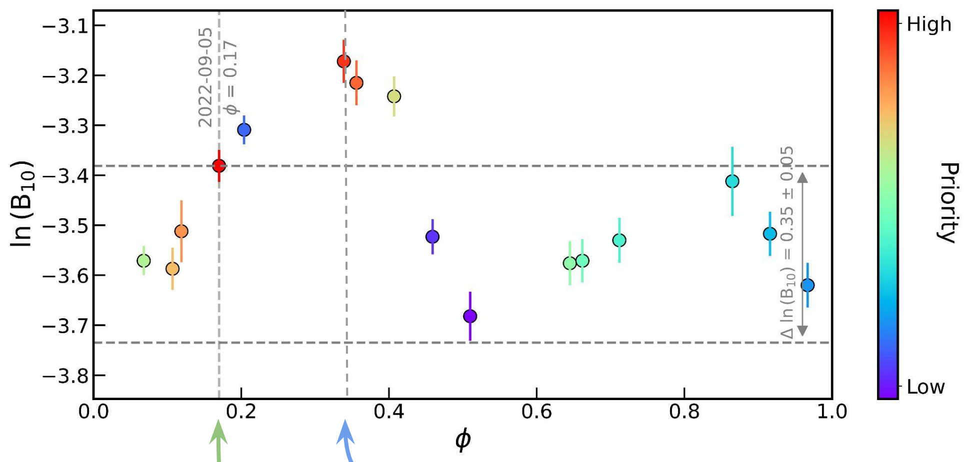
	N_{obs}	N_{days}
K	: 64	1472
K_β	: 82	469
MC	: 122	891

Observational Strategy

STEP 1: gather data following a **conventional strategy**
e.g., Monotonic cadence strategy



STEP 2: target the **predominant period** with **`KOBEsim`** algorithm
`KOBEsim` ranks the next observing candidate dates (candidate orbital phases ϕ) based on the expected Bayes factor increase



This date maximizes the Bayes factor (K)

This is the optimum date weighting the Bayes factor with a beta function (K_β)

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