Stefano Bellotti

Title

Mitigating stellar activity using line selections for Least-Squared Deconvolution

Abstract

Stellar activity poses a severe limitation to the search and characterisation of small exoplanets with the radial velocity method. This is particularly important for M dwarfs, as they are crucial targets for both ground-based instruments (e.g., SPIRou, NIRPS, CRIRES) as well as space-based missions (e.g., JWST, ARIEL), but can manifest high activity levels over long time-scales. Efficient activity filtering techniques are therefore necessary to disentangle genuine planetary signatures and improve the detectability. In this context, and knowing from previous studies that different spectral lines are affected differently by magnetic activity, we developed a new mitigating technique based on a randomised selection of lines to use in Least-Square Deconvolution (LSD). We benchmarked the analysis on optical spectropolarimetric time series of the active M dwarf EV Lac collected with ESPaDOnS at CHFT, obtaining a reduction of the radial velocity dispersion by at least 50-60%. A similar and consistent improvement was also found when targeting stars of analogous (AD Leo) and lower (DS Leo) activity levels. Finally, we injected synthetic planets with semi-amplitudes between 60 and 120 m/s (i.e. 0.3-0.6 MJup) in our data sets containing moderate (20 m/s) and high (200 m/s) activity levels and we retrieved reasonably unaltered planetary signals, indicating that our technique does not suppress these signals substantially.

Stefano Bellotti

📍 7 rue St. Thomas d'Aquin, 31400, Toulouse, France

✉ stefano.bellotti@irap.omp.eu

📞 +39 334 9983326

iD https://orcid.org/0000-0002-2558-6920

Current position

2020 - present	Ph.D. student at the Institut de Recherche en Astrophysique et Planétologie (IRAP), Université Toulouse III - Paul Sabatier, Toulouse, France
	Title: "Searching new worlds with SPIRou: tackling stellar activity"
	Supervisors: Pascal Petit (IRAP), Julien Morin (LUPM), Gaitee Hussain (ESA)

Education

2017 - 2019	MSc in Astrophysics, Niels Böhr Institute, University of Copenhagen, Denmark.
	Title: "Stellar activity induced detection limits for habitable zone planets around a representative sample of known planet hosts"
	Supervisor: Heidi Korhonen
	Grade: A
2013 - 2017	BSc in Physics, Physics Department, University of Pavia, Italy.
	Title: "Measurement of Planck's constant for didactic purposes: comparison of possible methodologies"
	Supervisor: Anna de Ambrosis
	Grade: 104/110

Publications

Martioli E., +5 others, **Bellotti** S., +53 others, "*TOI-1759 b: a transiting sub-Neptune around a low mass star characterized with SPIRou*", submitted to Astronomy & Astrophysics.

Bellotti S., Petit P., Morin J., Hussain G. A. J., Folsom C., "*Mitigating stellar activity jitter with different masks for least-squares deconvolution: Analysis of a parametric and a randomised line selection*", 2021, Astronomy & Astrophysics, in press.

Bellotti S. and Korhonen H. "*Simulating starspot activity jitter: realistic estimates for a representative sample of known F--M exoplanet hosts*", 2021, Astronomische Nachrichten, in press.

Bellotti S., Zabludoff A., Belikov R., Guyon O., Rathi C. "*Detecting Exoplanets Using Eclipsing Binaries as Natural Starshades*", 2020, The Astronomical Journal, 160, 131.

Stritzinger, +4 others, **Bellotti**, +4 others, 2018, "Transient Classification Report for 2018-08-16".

Fynbo, Ardevol Martinez, **Bellotti**, +3 others, 2018, "Transient Classification Report for 2018-08-30".

Observing experience and proposals

PI of NEO-NARVAL@Telescope Bernard-Lyot proposal for 119.8 hours in semester 2021A.
PI of SPIRou@Canada-Hawaii-France proposal for 7.2 hours in semester 2021B.

Nov 2021	Service mode operation for 8 nights at Telescope Bernard-Lyot.
Aug 2018	MSc course "Observational Astronomy": observing, data reduction with IRAF and analysis for 7 nights at Nordic Optical Telescope, La Palma, Spain.

Conference participation

Oct 2021	Poster presentation at the Star-Planet Connection online conference with the title: "*Simulating starspot activity jitter for spectral types F–M: realistic estimates for a representative sample of known exoplanet hosts*".
Feb 2021	Poster presentation at the CoolStars20.5 online conference with the title: "*Spectropolarimetry in optical and near-IR for EV Lac and AD Leo: what is stellar activity's favourite colour?*".

| May 2019 | Poster presentation at the Annual Danish Astronomy Meeting, Nyborg, Denmark with the title: "*Hunting exoplanets: detection limits due to starspots*". |

Coding

Python	Upper intermediate: cluster usage and astronomical packages (AstroPy, PyRAF, Pyfits, Astroquery)
C++	Basic (didactic) level
Office suite	Upper intermediate

Language

Italian	Native
English	Fluent in both spoken and written (IELTS level C1, 2017)
French	B1

Voluntary work

Dec 2020 - May 2021	Member of the organizing team of the "PhD Day 2021": a one-day event dedicated to PhD students to showcase their research and foster collaborations. Held online, Toulouse, France.
Sep 2020 - Dec 2020	Member of the editing team of the "*Newcomer's guide at IRAP*": a problem-solving document to describe all aspects of the PhD student's life at IRAP, Toulouse, France.
Oct 2018- May 2019	Bartender at Studenterhuset, Copenhagen, DK.

Leisure interests

I like to have an active lifestyle both mentally and physically. Therefore, I train at the gym and jog a few times a week. I also relax best when I read books, especially sci-fi and fantasy ones, or when I experiment new recipes in the kitchen.