Dr. Jan van Roestel

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Current

2018-present **Postdoctoral researcher, Astronomy and Physics**, California Institute of Technology
Galactic science working group lead for the Zwicky Transient Facility-collaboration; searching for compact, relativistic binary systems with ZTF and machine learning classification of variable stars with ZTF.

Education

2013-2018 **PhD in Astronomy and Physics**, Radboud University; supervisors P.J. Groot & T. Prince (Caltech) & S.R Kulkarni (Caltech)
Thesis: ***"Fast optical variability with the Palomar Transient Factory"***
For my PhD thesis, I used data from the Palomar Transient Factory (PTF) to determine the rate of intra-night transients in preparation for the search for kilonova. In addition, I worked on data-mining PTF to find short period white dwarf binary stars. PhD awarded 27-10-2018

2011-2013 **MSc in Astronomy and Physics**, *Cum Laude*, Radboud University; supervisor P.J. Groot
Thesis topic: *A new eclipsing white dwarf - red dwarf binary star in the CV period gap.* As part of my curriculum, I did the courses "Star and Planet formation" (6 ECTS) at the University of Amsterdam and attended the "Binary stars" summer-school (3 ECTS) at Leuven University (BE).

2008-2011 **BSc in Physics**, Radboud University; BSc. thesis supervisor G. Nelemans
Thesis topic: *Radial velocity study of a pulsating sdO star.*

Computer skills

Programming: PYTHON, LaTeX, SHELL
Data tools: NUMPY, SCIPY, PANDAS, XGBOOST, KERAS, SKLEARN
Astrophysics: IRAF, ASTROPY, LCURVE, MOLLY, various automated reduction pipelines for optical imaging and spectroscopic data

Telescope and observing experience

'19-'21 **PI and Co-I** of the **ZTF deepdrilling survey** (≈100hrs/yr)
'19-'20 Responsible for writing the proposal and executing the ZTF partnership Galactic plane surveys 2019 & 2020

'19-'21	**PI 10 nights** Keck for followup of periodic and outbursting compact binaries found with ZTF.
'19-'21	**PI 22 nights** 5m Hale telescope for followup of ZTF binaries.
'17-'19	**PI 25 nights** at the WHT and INT for followup of PTF binaries
July/August '17	Assembling and commissioning the MEERlicht telescope at Sutherland Observatory, SA
'16-'17	**PI of Sky2Night2@PTF**. 16 nights of PTF and the 10 nights of INT time for a survey to study intra-night transients with immediate spectroscopic followup.

Talks

Sept. '20	ESO Garching; *Searching for compact binaries with ZTF*
March '20	Radboud Nijmegen; *Searching for eclipsing AM CVn binaries with ZTF*
June '20	EAS Leiden; *Machine learning classification of ZTF variable stars*
June '20	EAS Leiden; *Exploring the population of compact binaries with ZTF*
'18-'20	ZTF biannual team-meetings; *update by the variable star science working group*
Sept. '19	CWDB meeting Yerevan; *Exploring the population of compact binaries with ZTF*
May. '19	DWD meeting Copenhagen; *Searching for double white dwarfs with ZTF*
Feb. '18	Seminar speaker KU Leuven; *Rapid variability with PTF*
Feb. '17	UCSB DISK program; *Machine learning classification of low-mass white dwarfs.*
Oct. '16	"Hot-wiring the transient Universe" (Villa Nova Univ., USA), *transient rates and the Galactic foreground fog with PTF*
May '14	PTF team meeting Stockholm; *PTF intra-night transients*
May '14	Dutch Astronomy Conference; *Rapid variability with PTF*

Teaching

Summer '20	**Supervisor of SURF summer student** Leah Creter working on finding AM CVn binaries with ZTF.
June '19	**Teaching high school students** attending a summerschool for 2 weeks.
Feb.-June '17	BSc. thesis supervisor of Rutger Jaspers.
Oct.'16-Feb.'17	BSc. thesis supervisor of Rick Oosterwijk.
Aug. '14	**PTF summer school** preparing and presenting a 2hr problem session.
'13-'16	**Coordinator** of the problem classes and TA for "Introduction in programming", a course for ∼150 first year Physics and Math students. I was responsible for the logistics of the problem classes as well as helping students with any questions related to the content of the course.
'11-'15	**Teaching assistant** for "Observational astronomy" (2x), "Introduction to Cosmology", "Introduction to Astronomy" (2x),

Outreach

'15&'16	A **45-minute talk** about the transient universe for the general public visiting the open observing night at Radboud University.
'16	Co-organising the observations of the **transit of Mercury** at Radboud University.
'11-'16	Regular **telescope tours** for prospective students and the general public.

Last updated: December 20, 2020

Publications and projects

PI/first author:

present **ZTF Scope (Source ClassificatiOn ProjEct)** The Zwicky Transient Facility is producing vast amounts of data and has collected lightcurves for 2 billion objects. The first step in doing science with this data is the identify and classify the many different types of variables. With PTF, I explore the potential of machine learning classifiers and their potential to classify variable star lightcurves. With ZTF, I am leading the effort to identify and classify all persistent objects. This is a huge multi-class, multi-level classification problem with different requirements on purity and completeness. We therefore came up with an alternative approach; instead of using one machine learning classifier, we are using multiple separate classfiers which classify binaries at different levels completely independently. This allows for much greater flexibility and insight. *The first paper as been accepted with minor revisions*

present **Uncovering the population of AM CVn binaries with ZTF** AM CVn binaries are white dwarfs which are accreting from a degenerate companion. Their orbital periods are 5-65 minutes. These systems are rare (70 in total), and their formation scenario is uncertain. Their orbital period evolution is governed by angular momentum loss due to gravitational wave radiation. Together with detached double white dwarfs, they are the most common type of detectable LISA binary. Due to the accretion process, the orbital period is increasing average over long timescales, but it is uncertain how they evolve on shorter timescales. With ZTF, I have been searching for eclipsing AM CVn system. Because they are eclipsing, the physical properties of the system can be precisely measured. In addtion, the eclipse allows us to measure changes in the orbital period. *The first paper in prep.*

present **White dwarfs with dark-companions** Short period white dwarf binaries are born from close main-sequence binaries that go through a common-envelope phase. This creates a short period binary with a white dwarf and a low mass companion. Angular momentum loss (magnetic braking, gravitational wave radiation), moves these system close together and forms a CV (or similar accreting binary). Since the white dwarfs are typically many times smaller but a lot hotter. Although these systems are typically faint, eclipses are deep and easy to identify with photometric surveys. With ZTF, I have collected a sample of over 800 such systems. Most of them are regular white dwarf-dM systems, but there are also intresting subsets. 1) we are finding the 'hidden' population of period-bounce CVs. 2) eclipsing magnetic white dwarfs binaries 3) long period white dwarfs with brown dwarfs/giant planets. *The sample paper and first followup paper in prep.*

2019 The **Sky2Night 2&3** projects are two week-long projects where we used the PTF telescope to systematically observe a large field on the sky at low Galactic latitudes ($|b| < 20$). During the same time, we used a dedicated telescope (INT, P60, and Hale telescope) to observe all new transients discovered in this field, to get an unbiased sample of transients. The main goal of this project is to explore the fast transient sky in our own Galaxy, and determine the observed rate of (mainly interacting binaries). The proposals, planning, execution and analysis of these two short projects were entirely done by me. *Published as a chapter in my PhD thesis*

2019 The **Sky2Night project** is an 8-day project were we used the PTF telescope to systematically observe $400\,\mathrm{deg}^2$ at a 2-hour cadence. At the same time, we used the WHT telescope to observe all new transients discovered in this field, to get an unbiased sample of transients. With the data I have determined a robust observed rate for extra-Galactic and Galactic transients. In addition, we have calculated an upper-limit to the rate of fast optical transients. This work is in preparation for the systematic search for Kilonovae (the optical counterparts to NS-NS mergers detected by LIGO/Virgo). For this project, I have been responsible for the analysis and interpretation of the data. **van Roestel** *et al. (2019)*

2017

The discovery and analysis of **eclipsing white dwarf - M-dwarf binary** PTF0857. I combined high cadence photometry with phase-resolved spectroscopy to determine the system parameters using Bayesian statistics. This eclipsing white dwarf - red dwarf binary has an orbital period of only 2.5 hours. This puts this binary in the CV period gap. The canonical CV evolution theory predicts that CV will cease mass-transfer, and will look like detached systems. With our knowledge of the system parameters, we concluded that PTF0857 is not likely to be such a systems, but emerged from the common envelope as we observe it today. **van Roestel** *et al. (2017)*

2017 **EL CVn binaries in PTF**. I developed a machine learning method to discover EL CVn binaries (eclipsing binaries containing a pre-He-WD) in PTF light curve data, more than doubling the known sample size. In addition, I obtained spectroscopic follow-up observations using the IDS@INT (17 nights). We have determined the system parameters for all systems. We show that there are a large number of pre-He-WDs observable. Detailed follow-up of these systems will enable a detailed test of low mass stellar evolution models, binary interaction models and pulsation models of low mass white dwarfs. **van Roestel** *et al. (2018)*

Paper with significant contribution as co-author

2019 Contributed as an observer both with spectroscopy and high cadence photometry and the modelling of the lightcurve. Burdge et al. (2020)

2016 For PTF1 J0823, one of the shortest period eclipsing SdB binaries, I did the light curve analysis and calculation of the system parameters. Second author, Kupfer et al. (2017b).

2017 For OW J074106.0-294811.0, a 44-minute sdO binary, I did the light curve analysis and calculation of the system parameters. Third author, Kupfer et al. (2017a).

2016 The discovery of the first "white dwarf pulsar"! I obtained high cadence spectroscopy of AR Sco which shows the rapid spectral evolution of the system (∼2 minutes). Marsh et al. (2016).

2019 Contributions to commisioning and operation of ZTF (Bellm et al., 2019; Mahabal et al., 2019) and testing of the Kitt Peak EM-CCD (Coughlin et al., 2019).

A complete list of papers can be found on `https://ui.adsabs.harvard.edu/`. For most of these other papers I contributed as an observer or as a ZTF-team member.

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