BRITE-Constellation and Its Scientific Highlights

Shoebox-sized satellites for variable star research

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B. Pablo, D. Baade, M. Kenworthy, D. Reese, T. Van Reeth, R. Kuschnig, and the BRITE-Constellation Executive Science Team (BEST)
SPACE TELESCOPES

Hubble Space Telescope
2500M€

one BRITE < 0.7M€

roughly to scale…
**The BRITE Nano-Satellites**

- **Mass:** 7 kg
- **Size:** 20 x 20 x 20 cm³
- **Telescope Diameter:** 3 cm
- **3-Axes Stabilization**
- **24° x 24° Field of View:** Fits Orion completely
- **Pixel Size:** 9 μm x 9 μm
- **Power Consumption:** 5 - 10 W
## BRITE-Constellation

<table>
<thead>
<tr>
<th>Country</th>
<th>Satellite Name</th>
<th>ID</th>
<th>Launch</th>
<th>Orbit-P(min)</th>
<th>Filter</th>
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<td>UBr</td>
<td>2013-02-25</td>
<td>100.37</td>
<td>red</td>
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</tbody>
</table>

**Goal:** Measuring the light of 15 - 30 brightest, most luminous stars per field for up to half a year continuously
BRIGHTNESS VARIATIONS OF STARS

Binaries

Young stars / Stars with disks

Planetary Transit

Pulsating stars

Rotating stars: spots

13 March 2019
BRITE-Constellation Science

- Massive blue supergiants
- Red Giants
- $\beta$ Cephei stars
- Slowly Pulsating B stars
- $\delta$ Scuti stars
- roAp stars
- $\gamma$ Doradus stars

$V < 4.5$ (7) mag
BRITE FILTERS

BRITE Blue: 400 - 450nm

BRITE Red: 550 - 700nm
INTO SPACE...

Feb 25, 2013: 
Launch of the Austrian BRITEs from India

“BRITE in the box”
ALL BRITEs ARE IN POLAR LEOs

altitudes: 600 - 900km
OBSERVING STRATEGY

- Time series photometry for some of the **brightest, most massive and luminous stars** in the sky
- **15 - 30 stars per observing field** at once
- Time bases of **up to half a year** for a single observing campaign
- Observations during **15 - 30 minutes per orbit**
- 11 Megapixel CCD with 30 arcsec / pixel
  - selected **rasters** are read out
THE BRITE SKY

625 stars (multiple times) in 42 completed fields

Brightest: Canopus V = -0.72 mag
Faintest: HD 96265 V = 8.03 mag

BRITE Legacy Fields:
observed multiple times ➔ time bases of years
BRITE Target Statistics

Total: 526 stars

O: ~5%
B: ~50%
A: ~14%
F: ~11%
G: ~5%
K: ~11%
M & cooler: ~4%
**HIGHLIGHT I: A MASSIVE HEARTBEAT**

ι Orionis:
- O9 III + B1 III/IV
- high eccentricity $e = 0.764$
- short $P_{\text{orb}} = 29.13376\text{d}$

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ι Orionis: MESA & GYRE

$f_1$

$\Delta L$ (model, $m = 0$)
$\Delta L$ (model, $m = 2$)
$\Delta L$ (secondary, $m = 2$)
$\Delta L$ (observed)

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Pablo et al. (2017)
25 Orionis:
- B1 Vne
- $V = 4.96$ mag

- Excess angular momentum in Be stars
  - regular pulsation-driven ejection of matter

- Key: large-amplitude difference frequencies of non-radial pulsation g-modes

Highlight II: Be Stars

Difference frequencies

Baade et al. (2019, in prep.)
Highlight III: The β Pictoris System

β Pictoris:
- $T_{\text{eff}} = 8200 \pm 150$ K
- Age $\sim 23$ Myr
- δ Scuti pulsator

No Hill sphere transit observed photometrically

β Pictoris b:
- $M = 10 M_{\text{Jupiter}}$
- semi-major axis: 8 - 13 AU

International Observing Campaign:
Photometry & Spectroscopy
Amplitude Variability

Year of Observation

Zwintz et al. (2019, under review)
HIGHLIGHT IV: SURPRISE!

BRITE Carina II target stars

- eta Carinae
- WR 22
- HD 92063
- ASASSN-18fv

DSS image
**NOVAE**

**Nova Progenitors:**
- pair of red dwarfs in the process of merging
- white dwarf and another star

**Example:**
*Nova V5852 Sgr*  
**HIGHLIGHT IV: SURPRISE!**

**HD 92063**
- Red Giant
- K1 III
- V = 5.08 mag

FWHM 8 pixel, 27“/pixel, 4 sec exposures, 550 – 700 nm

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**BRITE – Toronto (BTr) Satellite**

discovery report „ASASSN-18fv“

signal from HD92063 only

~ t₀ of Nova

grey: individual measurements
red: orbital means (98 min)
BRITE data cover the evolution of the Nova Car 2018 with an unprecedented time resolution!

Aydi et al. (2019, in prep.)

grey: individual measurements
red: orbital means (98 min)
BRITE OPPORTUNITIES

- **Observing Proposals:** Submission any time
- **Contact:** konstanze.zwintz@uibk.ac.at

- **BRITE Photometry Wiki:**
  - Observed, ongoing, future fields
  - List of publications

- 10 future fields planned until 2020

- **Webpage:**
  - http://www.brite-constellation.at

- **Facebook:**
  - http://www.facebook.com/briteconstellation
BRITE-CONSTITUTION IN NUMBERS

6 YEARS IN SPACE

133 658 ORBITS

42 CAMPAIGNS

625 STARS OBSERVED

BRITE-Austria
UniBRITE
BRITE-Lem
BRITE-Heweliusz
BRITE-Toronto

NO FUEL USED

TRAVELLED 6.1 BILLION KILOMETERS
About the distance Earth - Pluto

63 GB SCIENCE DATA

171 PUBLISHED SCIENTIFIC PUBLICATIONS

4.3 MILLION DATA POINTS

LONGEST TIME BASE: 5.3 YEARS

2013 2019

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