LBTI: latest results and prospects

D. Defrère
University of Liège
The Large Binocular Telescope

Mt Graham, Arizona (10400 feet -- 3170 meters)
The Large Binocular Telescope

Mt Graham, Arizona (10400 feet -- 3170 meters)
The Large Binocular Telescope

**Resolution**
Beam combination provides the equivalent resolution of a 22.7-m telescope.

**High Contrast**
The AO system creates an image with a Strehl of >90% at 3.8 µm.

**Sensitivity**
LBT has two 8.4-m mirrors mounted on a single structure (collecting area of a single 11.8-m aperture).
The Large Binocular Telescope

**Resolution**  
Beam combination provides the equivalent resolution of a 22.7-m telescope.

**High Contrast**  
The AO system creates an image with a Strehl of >90% at 3.8 µm.

**Sensitivity**  
LBT has two 8.4-m mirrors mounted on a single structure (collecting area of a single 11.8-m aperture)
Key specificities

1. Common mount interferometer
   ⇒ No geometric delay
   ⇒ No long delay line
Key specifities

2. Deformable secondary mirrors
   => Low thermal background
The LBT interferometer (LBTI)

Resolution
Beam combination provides the equivalent resolution of a 22.7-m telescope.

High Contrast
The AO system creates an image with a Strehl of >90% at 3.8 µm.

Sensitivity
LBT has two 8.4-m mirrors mounted on a single structure (collecting area of a single 11.8-m aperture).
The LBT interferometer (LBTF)
The LBT interferometer (LBTI)

Diagram of the LBT interferometer (LBTI) with various components such as primary mirror, secondary mirror, tertiary mirror, fast pathlength corrector (FPC), slow pathlength corrector (SPC), universal beam combiner (UBC), nulling and imaging camera (NIC), and optical elements like LMIRCam, NOMIC, PHASECam, pupil wheel, grism wheel, filter wheels, and ND wheel.
The observing challenge includes:

- High-contrast AO imaging
- IFU imaging
- 1.5 to 13 µm
- NRM imaging
- Nulling interferometry
- Coronagraphy
- Dispersed interferometry
- Fizeau interferometry

Versatile instrument
LBTI science
LBTI surveys

- LEECH (planet survey): Stone et al. (submitted)
- HOSTS (exozodi survey): Ertel et al. 2018
HOSTS survey

- NASA-funded exozodi survey at 10 µm
- Main design driver for the Binocular nature of the LBT
- What is an exozodi?
HOSTS survey

- NASA-funded exozodi survey at 10 μm
- Main design driver for the Binocular nature of the LBT
- What is an exozodi?
Why an exozodi survey?

• Source of noise and confusion for future direct imaging missions
HOSTS: observing challenge

- 1 zodi around a 2-Jy star is \(~1\) million times dimmer than the background and \(~20000\) times dimmer than the star
- Signal mixed with the stellar PSF!
The Large Binocular Telescope

- Employing nulling interferometry
- 36 nearby main-sequence stars observed
The observing challenge

- Employing nulling interferometry
- 36 nearby main-sequence stars observed
The Large Binocular Telescope

N-band nulling with LBTI-NOMIC

Vega on 2014-03-17 at 12:58:03 UT
Instantaneous null: 23.31% ± 0.04%
HOSTS: results

- 36 nearby main-sequence stars observed
- Deepest N-band interferometric survey to date
- Exozodi more frequently found around stars with cold dust
- Good news for future imaging missions! Median exozodi density around “clean” stars < 16 zodis

Ertel et al. (2018)
ALES (Arizona Lenslet for Exoplanet Survey)

- First tests of system carried out on June 1-3 (2015).
  - spaxels are 25 mas.
  - FOV is 2.6’’
ALES (Arizona Lenslet for Exoplanet Survey)
The Vortex modes
The Large Binocular Telescope

AGPM-L4

AGPM-L14 (B8D2)
Several possibilities

- Single AO+AGPM imaging
  - L
- Single AO+AGPM imaging
  - R
- Binocular AO+AGPM imaging
  - L
  - R
- Binocular AO+AGPM imaging
  - L
  - R
- *New mode*
  - Single IFU+AO+AGPM imaging
  - R+L
The observing challenge

Optical setup

2015 (AGPM-L4&L14)

Lyot stop
Nov. 2013: first-light observations

- First-light observations on October 17, 2013 (AGPM-L4, 1 telescope)

- Only one side and with un-optimized Lyot stop

Peak rejection ~35:1
(far from optimal)

Gomez et al. 2017
Comparison with other instruments

Absil et al. 2016
ALES+AGPM observations

• Can be used with ALES (now field-of-view of ~3"")

• Re-aligned this summer

First AGPM+IFU image (beta Aur)  Spectral image cube (2.8 – 4.2 microns, R~20)

FOV (1.2”x1.2’’)

Data processing by Jordan Stone (UoA)
QACITS commissioning

- Implemented a IDL-Python wrapper to call QACITS
- Commissioned 1T QACITS
New optimized Lyot stops

- Ordered on Tuesday

Simulations done by B. Carlomagno
New optimized Lyot stops

Simulations done by B. Carlomagno
Status

• Only ~1 night on sky since 2013 (out of 3.5 allocated nights):
  * 0.5 night for HR8799 images
  * 2 hours for commissioning QACITS and testing new ALES+AGPM mode
  * 2.5 hours on HD179128

• Need observing time!
  * Losing expertise at LBT
Summary and future observations

- LBTI + AGPM is the most sensitive L-band imager
- IFU + AGPM mode (R=40) available
- Need observing time! No observing time since 2016B...
- Proposal for 2019A due by the end of September