MuSCAT & MuSCAT2: New Imagers for Precise, Multiband Photometry

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Multicolor Simultaneous Camera for studying Atmospheres of Transiting exoplanets (**MuSCAT**) is an optical three(grz_s)-band imager recently developed for the 1.88m telescope at Okayama Astrophysical Observatory in Japan (Narita et al. 2015; Fig 1). It has achieved sub-mmag photometric precisions (Fukui et al. 2016a) and succeeded in detecting a transit of a habitable planet candidate (Fig 2). **MuSCAT2** is being developed for the TCS 1.52m telescope at Teide Observatory in the Canary Islands, Spain (Fig 3 & 4). It is an upgraded version of MuSCAT having an additional channel (i band) (Table 1). Both instruments are useful for sciences that require high precision multiband photometry, and expected to produce fruitful results in the exoplanet field.

MuSCAT

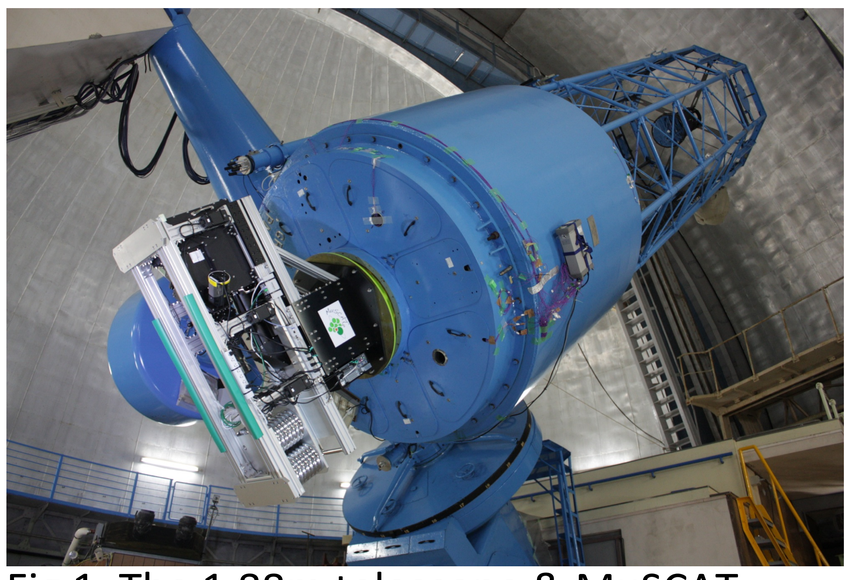

Fig 1. The 1.88m telescope & MuSCAT

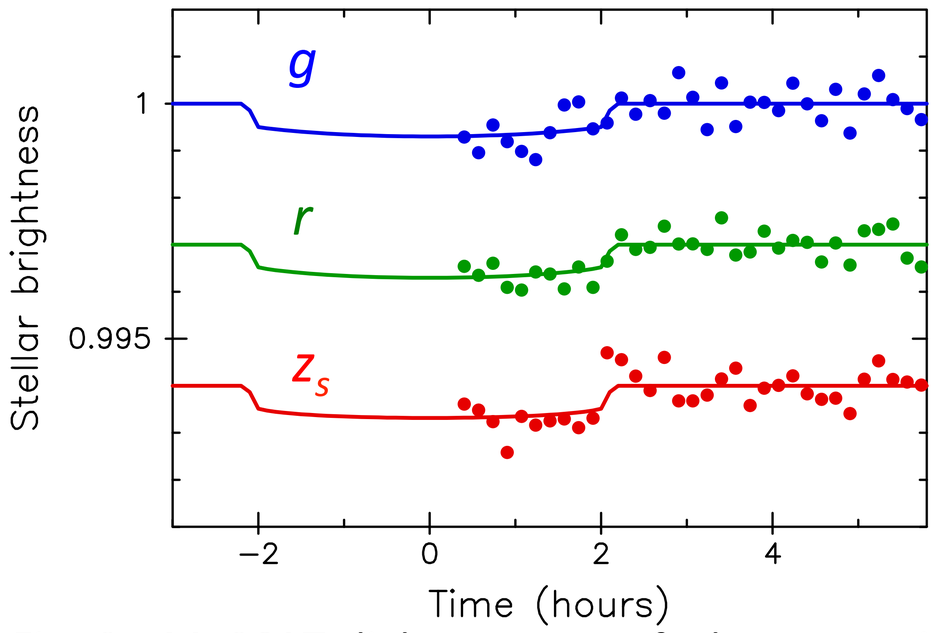

Fig 2. MuSCAT light curves of the potentially habitable planet K2-3d. Just a 0.07% depth of the transit was captured (Fukui et al. 2016b)

MuSCAT2

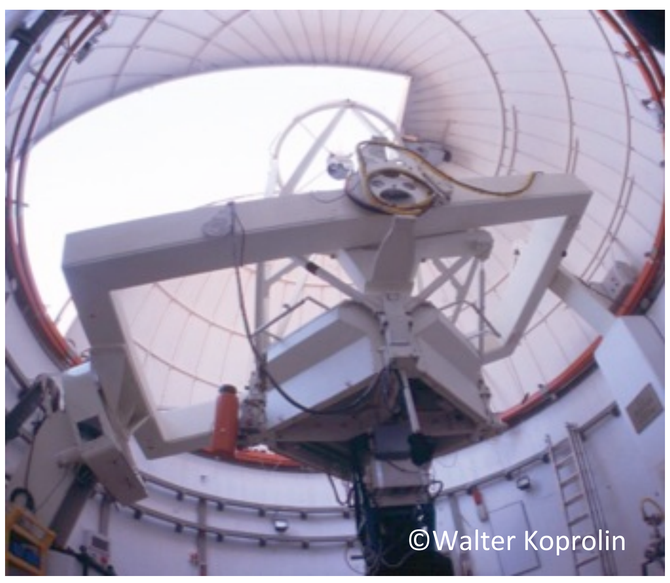

Fig 3. The TCS 1.52m telescope

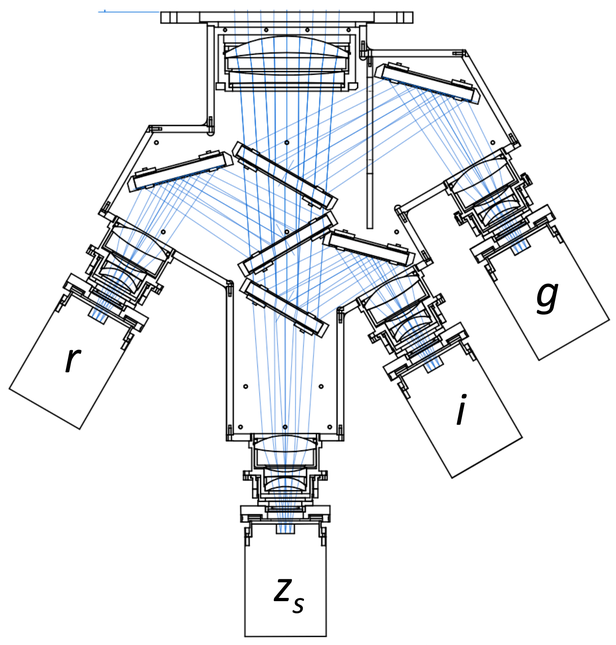

Fig 4. Optical layout of MuSCAT2

Table 1. Specs of MuSCAT and MuSCAT2

	MuSCAT	MuSCAT2
Telescope	OAO 1.88m	TCS 1.52 m
Elevation	372m	2387m
Clear night ratio	~30%	~70%
# of channels	3 (g, r, z_s)	4 (g, r, i, z_s)
FOV	6.1’ x 6.1’ (expandable to 12’ x 12’)	7.7’ x 7.7’
Pixel scale	0.36’’	0.45’’
Status	In operation (since 2015)	FL in 2017 summer

Possible Science: Observing Nearby Microlensing Predicted by Gaia

Although the main science purpose of MuSCAT and MuSCAT2 is observing transiting planets, in particular those that will be discovered by the K2 and TESS missions, they can also be useful for following up nearby microlensing events that could appear in the northern hemisphere. Given that already two microlensing events were detected outside the Galactic bulge by Gaia (Gaia16aua and Gaia16aye), more detections can be expected in the upcoming years. In addition, Gaia will provide precise stellar positions and proper motions of a billion of stars down to 21th magnitude, allowing us to “predict” future microlensing events.

These Gaia events will be worth observing because the distances of both source and lens stars are measurable by Gaia itself, allowing accurate mass measurements of the lens stars. The astrometric microlensing effect, if detected, could also help to constrain the lens mass (e.g., Proft et al. 2011). As microlensing is the only way to measure the absolute mass of single stars, these observations will be valuable not only for detecting nearby planetary systems but also for the study of the mass-luminosity relation of single stars.

MuSCAT and MuSCAT2 are useful for this observation because their multband information can be used to identify true (achromatic) microlensing events as well as they can capture very low magnification events of even a percent level. Please contact me (afukui@oao.nao.ac.jp) if you are interested in this observation.

References: Narita, N. et al. 2015, JATIS, 1, 045001; Fukui, A. et al. 2016a, ApJ, 819, 27; Fukui, A. et al. 2016b, AJ, 152, 171; Proft, S. et al. 2011, A&A, 536, A50