

Thermal infrared astronomy : an tailor-made site at Dome C

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1- Introduction

Numerous campaigns have demonstrated that the properties of the atmosphere above the Antarctic Plateau are unique on Earth, especially at Dôme C. The french-italian polar station Concordia is located at Dome C, on the Antarctic plateau, a site whose qualities are exceptional for thermal IR.

France has developed there, together with Italy, a continental base operating all year round since 2005, located 1100 km from Dumont d'Urville station on the coast.

Already by the end of 2010, the european ARENA network stated that the exceptional atmospheric conditions make the site uniquely favorable for infrared astronomy.

2- Atmospheric properties of Dome C

At an altitude of 3200m, with very little wind and temperatures that never exceed -20°C and go down to -80°C, the thermal IR background is very weak. We also have a low sky brightness (20 to 100 times lower than at mid-latitudes) and the site is very dry : the precipitable water vapor is only a quarter of mm during winters. The infrared transmission is great.

Therefore, conditions are optimal for mid-IR and the 200 μm and 350 μm windows open. In addition, dome C has a very special quality because 90% of the turbulence is concentrated in a thin ground layer below 40-50m : during 23% of the time, the ground layer is below 8m and 50% of the time below 25m. Above this ground layer, the « free atmosphere seeing » is 0.34 arcsec at 500 nm (Aristidi et al, 2009). During the Antarctic winter at Concordia, 67% of the time are photometric weather conditions (Crouzet et al. A&A 2010, 2018)

3- Science drivers and telescope project

Three top science drivers that will take benefit from observations in polar environment, they are: (1) Exploration of the distant univers, survey of SNIa in dusty galaxies and nature of the dark matter, (2) Characterization of extragalactic stellar populations and (3) Discovery of extrasolar planets, low mass stars.

To take advantage of Dôme C's conditions, our project is to place at Concordia a 2.5m off-axis telescope, designed by Gil Moretto (Moretto et al, 2012), optimized for low scattered light, low emissivity and wide field of view. This off axis concept is the only one complying with science cases and giving the highest possible dynamic range for photometry, the most reduced self thermal emissivity and a high angular resolution.

Telescopes are already in operation at Concordia. One of them is ASTEP: Antarctic Search for Transiting Exoplanets , a 40 cm telescope developed and managed by T. Guillot's team from Côte d'Azur Observatory and installed at Concordia since 2010.

Some of ASTEP's results are : the first ground-based visible detection of a secondary eclipse in 2013 (of planet WASP-19b (Abe et al. 2013)), long continuous observations of β Pic (Mékarnia et al., A&A 2017) leading to the discovery of a second planet β Pic c (Lagrange et al. Nature Astronomy 2020). ASTEP is now working on the follow-up of TESS targets. An upgrade is underway to increase its IR observations capabilities.

Polar conditions are really difficult, electric power capacities of Concordia must be increased but for MIR observations in the future, Dôme C is one of the places to be.

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