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ANTARCTIC OPTICAL/IR ASTRONOMY, BRIGHT FUTURE OR DEAD-END

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Abstract. A few thoughts about optical/IR Antarctic astronomy 3 years after the conclusions of the European network ARENA.

Keywords: Antarctica, Infrared Surveys, Astronomical prospects

1 Antarctic astronomy, the context

A decade ago, many optical/IR astronomers were keen on the awesome potential of the Concordia station at Dome C to carry out breaking observations at almost every wavelengths and envisioned the study of an international facility over there.

Although millimetre-wave observations had been carried out for several decades from the US station Amundsen–Scott at the South–Pole, mostly to investigate the properties of the cosmological background, very little was done in the optical/IR range, except the Australian–US SPIREX attempt (Burton *et al.*, 2000). Promising prospects were expected with the opening of the French Italian station Concordia at Dome C, the first exciting measurements of the optical turbulence properties above this site (Lawrence *et al.*, 2004, Aristidi *et al.*, 2009) and IRAIT, the Italian project of 80-cm infrared telescope. Prospects were also made to study the design of larger instruments including 2-m multipurpose telescopes such as the Australian PILOT or even more sophisticated optical/IR interferometers and radiotelescopes.

By 2005, the enthusiasm of astronomers leads in Europe to the creation of a coordinated action of the Research Infrastructure (FP6) of the European Commission to evaluate the potential of Concordia in various observational techniques and spectral domains. The European network, ARENA, started activity in 2006 under my coordination. Although I had not been previously involved personally in Antarctic activity, my interest stemmed from the unique possibility of extending deep infrared wide–band surveys beyond the limit of 2.3 μm that cannot be adequatly overcome from the ground because of the high thermal brackground emission of the sky above usual ground sites.

Three years after the release of the decadal *vision* of ARENA (Epchtein 2010), I thought useful to take stock of the situation and revisit these prospects in a somewhat deteriorated context essentially dominated by the repercussions of the economical *crisis*, the uncertainties about funding large future projects such as the E-ELT in Europe, somewhat tempered by the rise up of the Chinese potential and enthusiasm with the creation of a new Antarctic station at Dome A (Kunlun) (see *e.g.*, *Phys. Today, Jan 2011*) a result of the International Polar Year (2007-8).

These facts lead me to propose this small workshop in the framework of the Sf2A annual meeting 2012, and in advance of the Symp. 288 to be held subsequently in Beijing (Burton *et al.*, 2013).

2 Prospects *vs.* reality

The ARENA network lasted for 4 years (2006-2009) with an overall budget of 1.3 Meuros. It dealt with 4 main topics: i) aggregate results and support new obervations of the atmospheric properties, mostly from Dome C, ii) evaluate the most suitable science cases that could take full benefit from Antarctic conditions, iii) draft instrumental concepts and support instruments already in their implementation phase, iv) estimate the logistics requirements to build and operate these instruments. It involved about 20 laboratories in 7 European countries

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(De, Fr, It, UK, Pt, Sp, Be) and Australia. Reports on the work achieved during the 4 years were essentially gathered in the proceedings of the 3 ARENA conferences (Epchtein & Candidi 2007, Zinnecker *et al.*, 2008, Spinoglio & Epchtein 2010), and the decadal vision. They resulted from an excellent collaboration between laboratories and the Polar Agencies. Accent was put on middle-size projects rather than on small size instruments that do not require international collaborations for their implementation and exploitation. This was mainly aimed to make a step forward from "team" instruments, to some facility managed in an international context. Unfortunately, the conclusions occured during the worst period of the "world crisis".

2.1 The ARENA conclusions

Six working groups were set up to propose a set of recommendations in their respective areas. Each of them supported a few science cases and one or several instrumental concepts able to undertake them. Their conclusions are summarized in six reviews dealing with, i) the study of a 2 m class wide field optical/IR telescope, ii) a prototype of optical/IR interferometer (called Aladdin), iii) a submillimetre-wave antenna (AST), iv) 3 small telescopes, namely, IRAT, Ice-T and SIAMOIS, v) BRAIN a project to measure the polarization of the CMB, and vi) a solar coronograph. These reviews were prepared by Burton *et al.*, Coudé du Foresto & Surdej, Minier *et al.*, Rauer & Deeg, De Bernardis *et al.*, Damé & Andretta, respectively; all published in the Proceedings of the last ARENA conference (Spinoglio & Epchtein 2010)

2.2 What remains of these conclusions

Several highly interesting and well advanced projects were simply abandoned even in the "small" category for lack of further funding and resources or for unability to set up a robust international collaboration, SIAMOIS, Ice-T and the large submillimetre-wave antenna, AST. Of course, unrealistic project such as KEOPS (kilometric interferometric array) or even ALADDIN were simply disregarded or put aside. What finally remained active in 2012 are, the IRAIT telescope, which will eventually get its first IR light in 2013 after a succession of disappointments and funding shortages, the ASTEP transit telescope currently producing fine data on planetary transits of extrasolar planets (Rivet *et al.*, 2013) and the CMB BRAIN project. Among the larger projects that made progress in the meantime is a 2-m class telescope following the PILOT phase-A study made by the Australians (Lawrence *et al.*2009abc), which, in my opinion, should be entirely dedicated to a new generation infrared survey (see section 3) and for which a European Consortium was set up to submit a proposal of Design Study in 2010 under the name *Polar Large Telescope (PLT)* (Epchtein *et al.*, 2010, 2011).

2.3 Antarctic Astronomy vision revisited

There is little doubt that the vision elaborated by the ARENA consortium for this decade will not be achieved, at least in the foreseen timeline. There are several reasons for that, number one is the crisis that stroke the entire world and particularly Europe. Besides, there is still persisting doubts about the feasibility of building and operating large instruments in polar environment, a loss of enthusiasm of most actors (*e.g.*, IRAIT project), the disappointments about the thickness and time behaviour of the turbulent layer above Dome C requiring the erection of extremely stiff towers of several tens of meters, the underestimation of development timeline, finally the lack of an extremely convincing (so called, "killer") science case that would justify the cost of a large facility. Is big Antarctic Astronomy in a dead-end? My answer, at the present time is yes at Dome C and for the optical/IR range, owing to the stressed economical environment and as long as there is no official strong international organization able to manage an overall astronomy programme in Antarctica. To overcome these difficulties, one must continue to improve and better specify the scope of the projects following the progress of other large instruments, to single out more accurately the specificity of the antarctic conditions and their advantages, proceed with comparative atmospheric monitoring on the various existing sites and, possibly, on still undocumented ones, implement and operate relatively low demanding resources demonstrators, for instance, Ground Layer Adaptie Optics devices, and towers to monitor the atmospheric parameters in the 20-30m height range above ice.

3 Toward a new generation of infrared large scale surveys, possible role of an Antarctic telescope

The next generation of large astronomical instruments either set up on the ground (30-40 m class telescopes such as the E-ELT the TMT etc..) or space borne (JWST) will require a new generation of large scale optical/IR

surveys, providing lists and basic properties of sources fainter by several orders of magnitudes than those archived in currently available databases (*e.g.*, 2MASS or even VISTA). In the optical range, the LSST, will probably provide the necessary bank of data, but little has been investigated to provide similar data in the near-infrared range, so far, in order to extend VISTA surveys to fainter magnitudes, longer wavelengths (K_d, L_s) and to the northern sky, possibly from an Arctic site (Greenland) providing atmospheric conditions german to those prevailing in Antarctica.

The present projects for a new generation IR survey are essentially SASIR a US-Mexican initiative to survey the sky from San Pedro Martir (Mexico) (Bloom *et al.*, 2009) and the NISSA project using the PLT in Antarctica (Epchtein *et al.*, 2011, 2013), which could make use of a 2 to 4 m off-axis mirror configuration (Moretto *et al.*, 2013), the KDUST telescope currently envisioned by the Chinese teams at Dome A, and the Australian project proposed by Mould (2011). Attempts are currently made to merge all these projects because they have very similar objectives.

4 Conclusions

Mainly for economical *"crisis"* reasons, but also for lack of a sufficiently striking science case, the development of optical/IR Antarctic Astronomy is now in standby (all recent attempts that I made to raise funding from EC and ANR failed and none was supported by our agencies). The worldwide interest raised 7 years ago has somewhat weakened and the much expected *"Europeanization"* of Concordia has essentially failed to the great disappointment of our potential partners. Althoug time is probably not ripe for big investments there, it does not mean that one must give up definitively, but clearly a great opportunity has been missed, mostly because of the versatility of our Research Agencies and their unability to set up a robust long term vision in this topic. Concordia costs quite a lot of money to the French and Italian tax payers and cutting a promising exploratory branch for which French and Italian teams are exquisitely well trained, expert and deeply involved is not an error, it is a fault. We are now facing a situation in which China, Australia and the USA will probably be able to set up a consortium that will manage an international project at Dome A, but without a renewed strong impetus, Europeans will certainly stay on the roadside.

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