The Cosmic Wheel and the Legacy of the *AKARI* archive – AKARI2017 Conference Summary

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1. INTRODUCTION

First of all, I am honoured and pleased to summarize this meeting, having been interested in, and sideways involved with *AKARI* since 17 years. Having worked with *IRAS* and *ISO* data in the 1990s in my AGN research, I got to know about *ASTRO-F/IRIS* in 2000, when colleagues from Japan attended the FIRSED2000 meeting in Groningen which I organized. Groningen became member of the IKSG/IOSG Consortium, established by Michael Rowan-Robinson and Matsumoto-san in October 2002, after the third Mission Planning meeting held in summer 2002, here in Tokyo. Within that consortium, Groningen image processing expert Do Kester, PhD student Guido van der Wolk and I spent time at JAXA, before and after the launch. I also promoted the ESA involvement in *AKARI*, through my contacts with ESA's Martin Kessler.

Concerning ESA, I had been appointed as one of the five *Herschel* Mission Scientists in 1997. This appointment will end soon: *Herschel* is reaching the completion of its post-operations phase, and is in fact two months now from its archival phase. I was very pleased when this *AKARI* Archive Meeting was announced, as the *Herschel* Science Team also dealt extensively with that subject.

The importance of a good Archive was stressed on the first day of our meeting, and we should compliment our *Spitzer* colleagues (who have seen now more publications from the Archive data than from Mission Projects). It cannot be stressed enough: *AKARI* covers all-sky, so basically contains a gold mine of Archive Data.

One should also stress the cosmic wheel of (GREAT) opportunities in the far-infrared/submm. We live in a golden era, transiting from *AKARI*, *Spitzer*, *Herschel*, and *Planck*, towards *JWST*, *SPICA*, ALMA, and *ORIGINS*, while at the same time 8–10 m telescope optical/NIR time is not difficult to obtain.

Before going over specific science areas, let me say that I have been thoroughly impressed by the variety and the quality of the *AKARI* research, foremost by Japanese and Korean-led teams, as presented here in contributed talks and posters. There has been considerable further progress since our Oxford *AKARI* Meeting in summer 2014. I also noted that *AKARI* spectra have stimulated new research into the chemical nature of the NIR-MIR Unidentified Infrared Bands, c.q., aromatic features.

2. SPECIFIC SCIENCE AREAS

AKARI has permitted advancement in virtually all areas of astrophysics. Let me mention some (personal!) highlights, as reported during the four days of this meeting.

Concerning the solar system, progress in our understanding of the zodiacal light was reported, in the form of an update of the best model, as well as a new approach of planet migration theory, from all-sky data. I was also impressed with the IRC asteroid studies – their classification and composition.

Excellent studies in the field of stellar disks were reported, dealing with both protoplanetary and debris disks. I was particularly impressed with the study of PAHs tracing the PPD evolution.

AKARI permitted detailed studies of the star-ISM connection, targeting AGB stars, planetary nebulae, and supernova remnants. *AKARI* together with *Herschel* allow a unique new approach of dust and gas in circumstellar matter.

AKARI carried out a nice galactic bubble census, including the PAH dissociation. Also the cold cloud survey is noteworthy.

AKARI made great contributions to the ISM dust and gas diagnostics and ISM astrophysics in general. We have now a better understanding of the PAH nature (charge/size) in different conditions/environs, and of the nature (aromatic/aliphatic) of the 3 μm feature. Nevertheless, much remains to be done combining archival data from *AKARI*, *Spitzer*, and *Herschel*, including spinning PAHs and PAH destruction.

The *AKARI* studies of the dust filaments in Taurus are truly impressive, as are the YSO studies. We have a better understanding now of the grain properties and the mass accretion processes. Like the *Herschel* Milky Way results, the *AKARI* images are transformational: can the community get cut-outs of these, in a user-ready format?

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I was struck by the *AKARI* studies of nearby galaxies, yielding the properties of gas and dust in late type disks and haloes, but also in early types (Atlas-3D) where interesting conclusions concerning the star-formation efficiency could be drawn. We were informed about IRC spectra of nearby galaxies delivering the 3.3 μm PAH features: can these (160!) spectra be made available, in a user-ready format?

Obviously, considerable *AKARI*-time went into studies of dusty starbursts, LIRGs, and ULIRGs. Among the prime results are: studies of NIR line ratios (Brackett α/β) suggesting a top-heavy IMF, new insights into ice absorption, and 3.3 μm PAH systematics.

AKARI permitted systematic studies of – not too distant – AGN, both unobscured and obscured. I was impressed with the multi-band SED classification, the AGN IR-line diagnostics, and the work dealing with the torus absorption. It must be mentioned that these results will continue to be important, because of the many (weak) hybrid systems: star-forming galaxies having a mildly accreting black hole are frequently observed in deep fields.

Concerning the cosmologically evolving star-formation rate SFR(z), *AKARI* has made highly significant contributions, and lots is still to come, also in combination with *Herschel* and the large optical/NIR telescopes on the ground. The evolving luminosity function for IR-selected galaxies from the NEP field, the 90 μm local luminosity function from the *AKARI* DFS, and the $z < 0.5$ ULIRG catalog are landmark results. Both the NEP and the ADFS studies yielded invaluable data and improved insights into the cosmic star-formation history and the AGN history.

3. CONCERNING THE ARCHIVE

The *AKARI* All-sky Survey and the additional selected areas represent a treasure trove for years to come, nicely complementing the *WISE* Survey. At least half a million bright FIR sources at 4 bands are readily available, and nearly a million sources at 9 and 18 μm (IRC). Some six thousand IRC spectra have become available recently, representing wonderful complements to the *Spitzer* IRS spectra. Obviously, the 2–5 μm range prepares us for *JWST*! Four thousand IRC images taken in the cold phase and an additional 4200 IRC images obtained in post-helium phase, at 2, 3 and 4 μm, are retrievable in a user-ready format.

However, where are the MIR all-sky image maps? Where are the MIR spectra and FIR images taken in the pointing mode? Would it be possible to provide these data as HPDPs (Highly Processed Data Products), together with some form of an *AKARI* e-Helpdesk? Please note that the Hubble Space Telescope saw a tenfold increase of data usage once these data were available as HPDPs! This is also very important from a political point of view, in order to maintain and stimulate interest in SPICA.

SPICA is the natural successor in the line *Spitzer-AKARI-Herschel-JWST*. ESA will choose three M5 missions soon. The *SPICA* Consortium is in good shape and has strong support. Europe wants *SPICA* but needs Japan! We need ambition and self-confidence, and our past conference was stimulating in that respect, and brought self-confidence. All in all, the future is FIR-bright. We have exciting times ahead with *JWST*, and eagerly await its Open Time Call.

FINALLY

For those of you who do not know: there is an *AKARI* comic; check out the original *AKARI* website (it would not be Japan without a comic ...) I acknowledge the hospitality of Nakagawa-san and his people during my most enjoyable Sagamihara work visit in 2008, and the good contacts between the *AKARI* team and the *Herschel* team. As for now: applause for Onaka-san and Yamamura-san and their teams in Japan and Korea for an excellent job, for the LOC, and for the Ito Center for providing this nice facility, bringing us this memorable conference.