Scientific Report
GAIA short visit project: Dynamics of the IC348 young stellar cluster
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<u>Purpose of the visit:</u> Kumar visited AIP, Potsdam to work with Dr. Scholz in order to learn and gain experience in astrometry and to carry out a proper motion study of a young and nearby open clusters namely IC348. This final goal of this work, as explained in detail in the approved project is to study the dynamics of young stellar clusters by starting with the proto-typical cluster IC348.

Studying dynamics of young clusters requires measuring proper motions and/or radial velocities at a high precision corresponding to a level of less than a few kilometers per second. Proper motions of cluster members relative to foreground and background stars have been measured to obtain distances to the clusters (for example: Scholz et al. A&A, 1999, 137, 305). Such work has traditionally utilized digitized Schmidt plate observations separated by 50years or more. And it results in an accuracy of ~3milliarcseconds per year which translates to ~4km/sec velocities for a cluster such as IC348. However, a major problem with the Schmidt data is its low sensitivity and poor resolution that hinders detection of individual young stars in an embedded cluster which is not very effective in mapping the internal velocity dispersions. While the predecessor to the GAIA mission, namely HIPPARCOS provides high-accuracy astrometry, it detected only the brightest stars which is again not useful for the purpose of our work. Alternatively, modern instrumentation and the era of Space Telescope began in the early 90's, however, no specific data was ever taken for a high-accuracy astrometric study. Nevertheless, the Hubble Space Telescope (HST) with its WFPC2 instrument claims an astrometric accuracy of 1milliarcsecond. The purpose of the visit was to use available archival HST data test our scientific goal of studying the dynamics of young stellar clusters, in the pre-GAIA era.

<u>Description of the work carried out during the visit:</u> Kumar obtained a crash course on the essentials of performing highly accurate astrometric analysis from Dr. Scholz. Kumar also presented a seminar at AIP on this topic and discussing its implications to our understanding of the IMF. The following specific data analysis was carried out at the same time. The HST/WFPC2 combination, although claimed to result in 1mas positional accuracy, it has never been tested on real data for young clusters. Moreover, to achieve this theoretical precision, three main issues have to be satisfied : a) observations have to be taken with exactly or similar instrumental and telescope set up, b) the detector distortions have to be accounted for and c) the observations in two epochs should be taken in exactly the same orientations and positions.
Two observational sets separated by ~8 years are available for the IC348 with the HST/WFPC2 combination satisfying roughly the first two conditions. However, the third condition is not satisfied for the available data set. We used single WFPC2 pointing in two epochs to avoid any effects of pointing and rotation effects, applied distortion corrections and extracted positions of overlapping stars. Various tests were carried out to evaluate the accuracy of the differential astrometry.

<u>Description of the main results obtained:</u> The main result obtained from our tests to verify the authenticity of astrometric accuracies indicate that an overall accuracy of 5mas can be achieved for the data set in hand, which has an epoch difference of 8 years. This implies that the absolute proper motion accuracies can be as good as 0.9mas/year for the field analysed so far. However this accuracy may not be applicable for the entire observed area of the IC348 young cluster and further data analysis is in progress.

Future collaboration with host institution: The work that is started in collaboration with AIP, will not only be continued until the end of this specific project, but further beyond in the area of dynamics of young clusters. One of Kumar's graduate student is also involved in the on-going project and we foresee a strong collaboration between Kumar and Scholz, with a possible involvement of other members of the milky-way and local volume group at the host institution.

Project publications/articles resulting or to result from your grant: The on-going project is expected to result in at least one refereed journal publication. If we succeed in mapping at least part of the motions of the members of IC348, it will result in a publication directly linked to the original goal. However, if our further experiments over the entire data set show that the stellar dispersions are not measurable to the required accuracy, then our publication will be a summary of the applicability of the space telescope data in conducting such experiments, its pros and cons, together with a discussion of observational recipes to make high precision astrometry possible in the future, through imaging observations with space telescopes. The conservative timeline to submit a manuscript to a peer-reviewed journal is another 6months (early 2013).