Exploring the Reliability of the Pan-Starrs1 Proper Motions as Compared to the PPMXL Data Set

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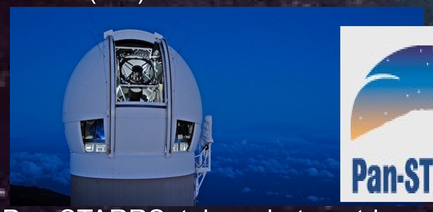
Introduction

Pan-STARRS, Panoramic Survey Telescope And Rapid Response System, went into operation three years ago, at the University of Hawai'i. The telescope is comprise of 4 separate mirrors, each with a CCD camera that contains 1.4 Billion Pixels, and each with a 3 degree FOV. Its mission is to serve as a killer asteroid hunter. In the process it surveys 6000 Square degrees of sky each night, collecting over a Terabyte of data in the process. It covers the entire sky three times each Lunar Cycle. This massive database allows for research into several other astronomical fields, particularly those which depend on time variability. Hence this data set is of great interest to those wishing to study the Proper Motions(PM) of Stars.



Pan-STARRS takes photometric measurements of objects, in the Optical G,R,I, and Z bands. It has the capability to cover the entire visible spectrum, including measurements of the near Infrared (NIR) Y band.

PPMXL is a compiled data set of Astrometric position measurements (Right Ascension (RA) and Declination (DEC)) and 2MASS (2 Micron all Sky Survey) photometric data in the NIR wavelength ranges, the J,H,K Bands of light, and the Optical B,R,I bands. PPMXL has been taking positional measurements of objects for over 30 years. And thus has Observed their PM's Combing this with 2MASS data the catalog has over 900 Million objects.

Why are we interested interested in Proper Motions?

Proper Motion is one observed quantity that can be used to determine Cluster Membership. Open Clusters are groups of several thousand stars that form from the same gas cloud. Thus they have the same metallicity, age, and distance from us. This makes clusters a good laboratory for the study of stellar evolution. Before this can be done you have to determine which stars are actually members of the cluster. A three fold method for determining membership produces a more accurate member list. These three methods are:

1) Restriction based on Proper Motion
2) Using Isochrones, CMD's
3) Position (RA, DEC)

"The Characterization of Low-mass Members in the Praesepe Star Cluster," by Chen et al discusses the membership determining methods used for the Praesepe Open Cluster (m44) In this paper PS1 data was not used since the PM's for this cluster have been determined to be inconsistent with PPMXL data.

Methodology

The main goal of the project was to determine the difference between proper motions measured by Pan-STARRS and those measured by PPMXL. PPMXL has been relied on in the past for proper motion measurements and the catalog has a large base. However, if Pan-STARRS measurements could replace PPMXL with relative accuracy then PS1 could be used more effectively due to the smaller frequency of measurements. The first goal was to replicate plots in a recent paper by Chen, et al.

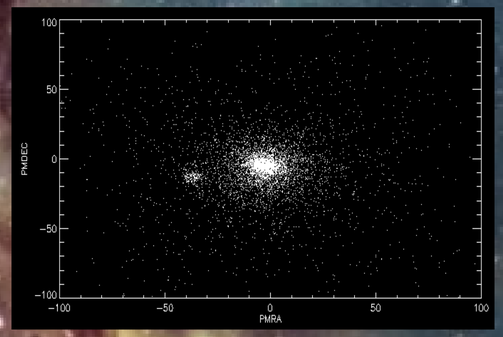


Fig. 1: Proper Motion Declination vs. Proper Motion Right Ascension for the Praesepe Cluster (m44). The plot shows a distinct separation between the proper motion of the cluster and that of the field stars. The cluster has a proper motion RA of approximately -37 mas, and a proper motion DEC of roughly -13 mas.

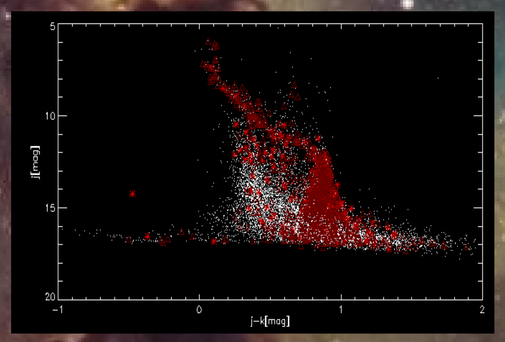
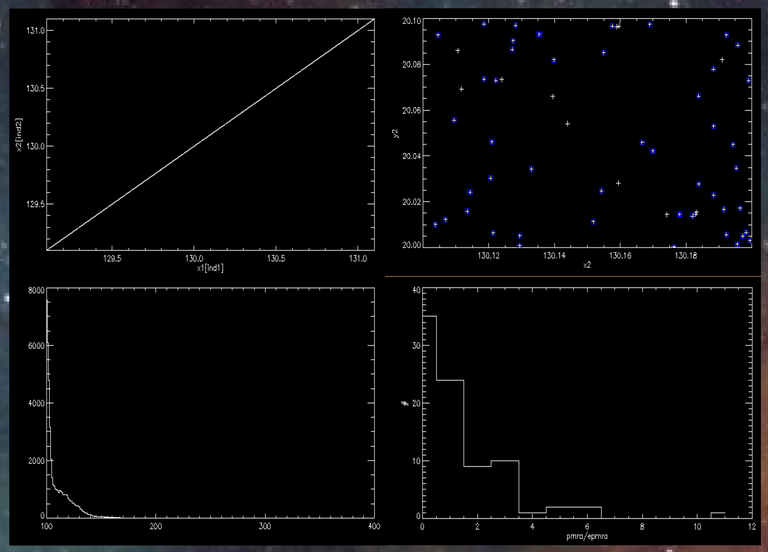


Fig. 2 A Color Magnitude Diagram for the Praesepe Cluster. White Dots are all PS1 stars. Red Asterisks are PS1 member candidates and Dark Red Triangles are PPMXL member candidates. This shows the characteristics s-curve isochrone for the cluster, which displays the main sequence, and the turn off.

After Replicating the plots from the Praesepe paper (Chen et al) the goal became to determine whether the two catalogs were consistent at all. To do this we used those stars with large PM's and small errors or the "reliable sample." By comparing only these stars we can determine whether there is any correlation between the two data sets. A 2D matching procedure in IDL was used to match those reliable stars from PPMXL to those same stars in the PS1 data set based on the Euclidean Position.



Figures 3A,3B,3C, and 3D (Clockwise from the top left respectively.) Figure 3A shows x2[ind2] vs x1[ind1] where x2 and x1 are the RA for PS1 and PPMXL respectively, and [ind1], [ind2] are matching indexes used to to find a star's match from one catalog to the other based on the Euclidean Position to within one arcsecond of the Star's position. This plot shows an almost one to one correlation between the two catalogs, based on position. Figure 3B shows the same matching result. Here y2 is the Declination for PPMXL and x2 is the Right Ascension for PPMXL. The Blue Squares represent matches for the PS1 data to the PPMXL data which is represented by the White Crosses. Figure 3C shows a binned Histogram of the Proper Motions for PPMXL. Figure 3D shows the Reliable sample of Proper Motions for PPMXL, defined by having a small relative uncertainty.

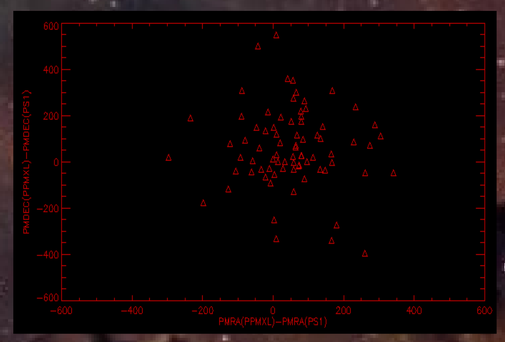


Fig. 4 Shows the difference in Proper Motion RA between PPMXL and PS1 data on the x-axis. The y-axis shows the difference between the Proper Motion Declination for PPMXL and PS1.

Conclusions

This indicates the large dispersion in PMRA and PMDEC that there is a significant difference in values for PPMXL and PS1 Proper Motion data. Further investigation into this is needed, however. There is a great deal of error associated with the matching procedures used such that the stars returned may be not the correct match. It is unlikely that this happened for the entire sample, however.