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ABSTRACT: Using two observations taken with the High Resolution Camera (HRC-I) aboard the Chandra X-ray satellite, we have examined the central compact object RX J0822-4300 for a possible proper motion. The position of RX J0822-4300 is found to be different by 0.574 ± 0.184 arcsec, implying a proper motion of 107.49 ± 34.46 mas/yr with a position angle of 241 ± 24 degree. For a distance of 2.2 kpc, this proper motion is equivalent to a recoil velocity of 1121.79 ± 359.60 km/s. Both the magnitude and the direction of the proper motion are in agreement with the birth place of RX J0822-4300 being near to the optical expansion center of the supernova remnant. Although this is a promising indication of a fast moving compact object in a supernova remnant, the relative large error prevents any constraining conclusion.

RX J0822-4300 is located about ~ 6 arcmin distant from the optical expansion center of Puppis-A (Winkler et al. 1998; cf. Fig. 1). The age of the supernova remnant, as estimated from the kinematics of oxygen-rich filament is ~ 3700 years (Winkler et al. 1988). If these estimates are correct, RX J0822-4300 should have a proper motion at the order of ~ 100 mas/yr to a direction away from its proposed birth place with a position angle of ~ 243 degree. RX J0822-4300 has been observed with the Chandra HRC-I with an epoch separation of 1952 days. The expected displacement of the CCO is ~ 0.5 arcsec in this time span.

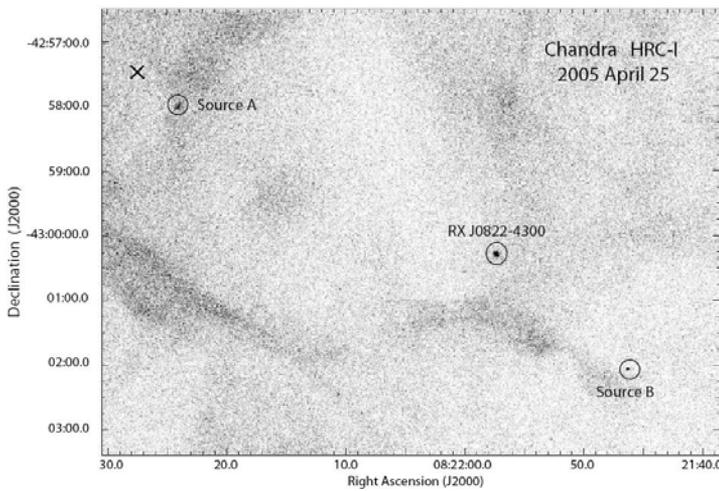


Fig. 1. Part of the Chandra HRC-I image of the Puppis-A supernova remnant. Besides RX J0822-4300, there are two serendipitous point sources detected in the field of view. They are denoted as source A and source B. The optical expansion center of Puppis-A as obtained by Winkler et al. (1998) is marked by a cross.

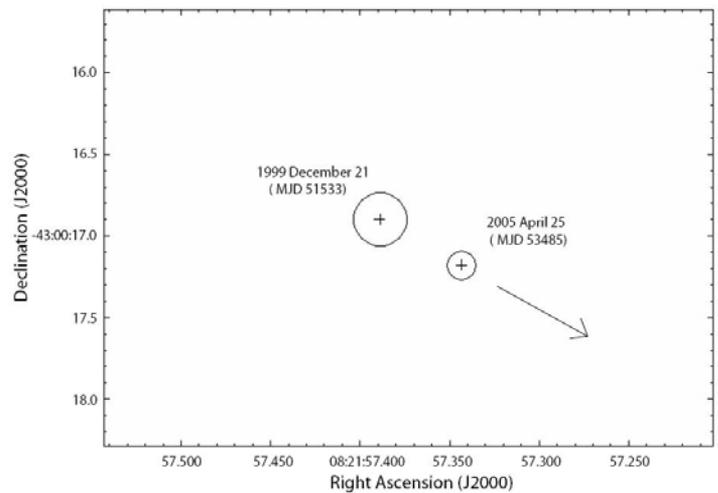


Fig. 2. The best-fitted X-ray positions of RX J0822-4300 in two epochs are marked by crosses. The circles indicate the $1-\sigma$ error. The arrow shows the direction of proper motion inferred from both positions.

To be able to correct the pointing uncertainty of Chandra, we used the sources detected serendipitously as the astrometric reference (see Fig. 1). Since the large off-axis angle (~ 5.5 arcmin) of source A causes a marked blurring of the PSF (90% encircled energy radius ~ 4 arcsec), the large distortion makes the source appear to be very dispersed and hence not allow us to obtain its position more accurate than 0.2 arcsec. This leaves the source B as the only reference to perform the aspect correction. Correlating the X-ray position of source B with the catalog UCAC2 (Zacharias et al. 2003), we identified its counterpart which itself has a proper motion in the southwest direction. Taking this star as an astrometric reference, we applied the astrometric correction in the corresponding frames. However, with only one comparison source available for the frame alignment, here are some limitations in our adopted method. Firstly, the roll angle between two frames cannot be determined independently with just one reference source. Hence, the accuracy of the current result is limited by the output of the star-tracking camera, the Pointing Control and Determination system (PCAD). Also, an independent estimate of the HRC-I plate scale cannot be made with only one reference source. The potential variation of the plate scale might introduce an extra error, though we consider this is negligible as the typical uncertainty of the HRC-I plate scale is at the order of ~ 0.05 mas/pixel. The fitted X-ray positions of RX J0822-4300 are plotted in Fig. 2. The circles illustrate the position error 0.162 arcsec and 0.088 arcsec for the corresponding epoch. The proper motion of the CCO is found to be 107.49 ± 34.46 mas/yr with a position angle of 241 ± 24 degree. This suggests that RX J0822-4300 is indeed physically associated with Puppis-A and its actual birth place is not too far away from the SNR's optical expansion center.

References

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