PARALLAXES USING INFRARED ARRAYS

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1. Abstract

We have recently carried out an infrared parallax programme on the UKIRT conducted with a 256^2 array. Our observations were made in the near-infrared K-band which is ideal for observing red stars and brown dwarf candidates and has the advantage that differential colour refraction is negligible. We find a parallax of $\pi_{\rm abs} = 156.0 \pm 13.3$ mas for the archetypal late-type M dwarf vB 10 and $\pi_{\rm abs} = 11.1 \pm 7.5$ mas for PC 0025+0447 which we conclude is too distant to be a clear case of a brown dwarf and is probably a late-type M dwarf close to the hydrogen-burning limit. Recent improvements in telescopes and instrumentation working in the infrared should enable accuracies of ~ 1 mas to be obtained for future infrared parallax programmes.

2. Accuracy of Future Observations

The accuracies for the parallax measurements in our programme are of order $\delta\pi \sim 10$ mas. The introduction of larger detectors in conjunction with tip/tilt or low–order correction adaptive optics systems promises to allow even greater accuracy to be attained in the K–band.

One can estimate the benefits such a system will deliver. A factor of two increase in accuracy will come from smaller image sizes with a tip/tilt system. A second factor of two can be obtained due to improved contrast for stars fainter than the background. A third factor of two comes from using a 1024^2 array. This will have 16 times more pixels than the 256^2 array in IRCAM3, but if a tip/tilt system is being used, the requirement of fully sampling the point spread function means that only 4 times the area on the sky can be viewed. Thus, we will have roughly 4 times as many reference stars, but we expect the accuracy to increase as $\sqrt{n_{\rm stars}}$. This larger number of reference stars will also reduce the residuals when constructing the global reference frame. Overall, we expect about an order of magnitude of improvement and that accuracies of $\delta\pi = 1$–2 mas are possible given current innovations making infrared-based parallaxes fully competitive with optically-based parallaxes for red objects.

As they become available we hope to include brown dwarf candidates and other red interesting objects discovered from large area surveys such as 2MASS, DENIS, EROS and SLOAN. Based on the case of the brown dwarf Gl 229B ($R_{F675W} - J_{CIT} = 10.6$, Oppenheimer 1997, in preparation) field brown dwarfs will be too faint for parallax observations to be made at visible wavelengths and infrared parallax programmes such as this will be essential.

The move to conduct parallax programmes at infrared wavelengths will enable observers not to be concerned critically about airmass when making measurements. This will make it considerably easier for parallax programmes to be conducted on common–user telescopes using queue–based scheduling.

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