MEASUREMENT OF PRECISION GEOMETRIC DISTANCES TO THREE ANCHOR POINTS IN THE LOCAL UNIVERSE

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Annual Report

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We proposed a program to measure distances directly with accuracies of 5% to three anchor points in the Local Universe. We planned to accomplish this by conducting Very Long Baseline Interferometry (VLBI) observations of NGC 4258, M 33, and Sgr A*. These distance estimates should have a minimum of systematic uncertainty and can be used to re-calibrate several "standard candles," such as Cepheid and RR Lyrae variables. This will place the Galactic and extragalactic distance scales on much firmer ground.

The primary contribution of our program will be to provide crucial independent checks and calibrations of extragalactic distance measurements. This will contribute to the ultimate success and impact of the HST Key Project on Extragalactic Distances and the Full-Sky Astrometric Mapping Explorer (FAME). Additionally, since distances are fundamental to astrophysics, our results will affect a large number of general projects on NASA facilities such as the HST, CXO, and NGST.

In the first (partial) year under our grant, we have made progress for each source:

1) NGC 4258: We have begun analysis of a large number of VLBA data sets, comprising bi-monthly observations over a period of over 1.5 years. We have discovered some software problems in the NRAO VLBA correlator/AIPS analysis path that limit the accuracy of positions measured from synthesis maps. We have devised a plan to avoid these problems and expect to achieve higher accuracy positions, which should improve the distance estimate.

2) M 33: We initiated VLBA observations this year, designed to directly determine the angular rotation rate of the galaxy by measuring the relative positions of two H2O masers in different star forming regions on opposite sides of the galaxy. Our first results for a similar type of observation on the galaxy IC10 demonstrated that we are achieving relative position measurements of 10 micro-arcseconds between sources separated by about 1 degree on the sky. This suggests that the M 33 masers, which are separated by less than 1 degree on the sky, should also achieve this accuracy. The first epoch VLBA observations of M 33 were made this year and are being currently analyzed.

3) Sgr A*: We are working toward the goal of obtaining a trigonometric parallax measurement for the compact radio source at the center of the Milky Way (Sgr A*). Currently we have achieved relative positional accuracy of 100 micro-arcseconds for this difficult target. The very low source declination and large (scattered) angular size of the source make it considerably harder to determine accurate positions compared, say, to M 33. We are currently analyzing calibration data, taken during some previous observing campaigns, that may help calibrate the largest source of systematic error: the large-scale atmospheric propagation delay at each antenna in the VLBA.

Overall, we are making significant progress toward our very ambitious goals of high accuracy, direct distance measurements to two galaxies and the Galactic Center.