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The geometric distance and binary orbit of PSR B1259-63

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The pulsar/massive star binary system PSR B1259-63/LS 2883 is one of the best-studied gamma-ray binaries, a class of systems whose bright gamma-ray flaring can provide important insights into high-energy physics. Using the Australian Long Baseline Array we conducted very long baseline interferometric observations of the pulsar inside the binary over 4.4 years, fully sampling the 3.4-year orbital period. The motion of PSR B1259-63 on the sky reflects its orbital motion, the proper motion of the system, and its parallax signature. Taking our findings together with previous results from pulsar timing observations, all seven orbital elements for the system are now fully determined. Our geometric parallax provides the first model-independent distance to the system. The system distance is used to lock the isotropic gamma-ray luminosity during gamma-ray flares. We use our measurement of the inclination of the orbit to constrain the mass of the stellar companion. Our measured distance and proper motion are consistent with the system having originated in the Cen OB1 association and receiving a modest natal kick. The orientation of the orbit on the plane of the sky matches the direction of motion of the X-ray synchrotron-emitting knot observed by the Chandra.