

Supplementary Material

Extended acknowledgements Aside from the Very Large Array and the Arecibo Observatory, the observational campaign reported here relied on several other telescopes and the analysis was supported by many different organizations. S.C., R.S.W., and J.M.C. acknowledge prior support from the National Science Foundation through grants AST-1104617 and AST-1008213. This work was partially supported by the University of California Lab Fees program under award number LF-12-237863. The research leading to these results has received funding from the European Research Council (ERC) under the European Union's Seventh Framework Programme (FP7/2007-2013). J.W.T.H. is an NWO Vidi Fellow and, along with C.G.B., gratefully acknowledges funding for this work from ERC Starting Grant DRAGNET under contract number 337062. S.P.T. acknowledges support from a McGill Astrophysics postdoctoral fellowship. M.W.A. was a participant in the 2016 Research Experience for Undergraduates in Astronomy and Astrophysics at Cornell University program, supported by grant NSF/AST-1156780. V.M.K. holds the Lorne Trottier and a Canada Research Chair and receives support from an NSERC Discovery Grant and Accelerator Supplement, from a R. Howard Webster Foundation Fellowship from the Canadian Institute for Advanced Research (CIFAR), and from the FRQNT Centre de Recherche en Astrophysique du Quebec. B.M. acknowledges support by the Spanish Ministerio de Economía y Competitividad (MINECO/FEDER, UE) under grants AYA2013-47447-C3-1-P, AYA2016-76012-C3-1-P, and MDM-2014-0369 of ICCUB (Unidad de Excelencia 'María de Maeztu'). L.G.S. gratefully acknowledge financial support from the ERC Starting Grant BEACON under contract number 279702 and the Max Planck Society. Part of this research was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration. S.C., J.M.C., P.D., T.J.L., M.A.M., and S.M.R. are partially supported by the NANOGrav Physics Frontiers Center (NSF award 1430284). The European VLBI Network is a joint facility of independent European, African, Asian, and North American radio astronomy institutes. ALMA is a partnership of ESO (representing its member states), NSF (USA) and NINS (Japan), together with NRC (Canada) and NSC and ASIAA (Taiwan) and KASI (Republic of Korea), in cooperation with the Republic of Chile. The Joint ALMA Observatory is operated by ESO, AUI/NRAO and NAOJ. Based on partial observations obtained at the Gemini Observatory, which is operated by the Association of Universities for Research in Astronomy, Inc., under a cooperative agreement with the NSF on behalf of the Gemini partnership: the National Science Foundation (United States), the National Research Council (Canada), CONICYT (Chile), Ministerio de Ciencia, Tecnología e Innovación Productiva (Argentina), and Ministério da Ciência, Tecnologia e Inovação (Brazil). This research has made use of the Keck Observatory Archive (KOA), which is operated by the W. M. Keck Observatory and the NASA Exoplanet Science Institute (NExScI), under contract with NASA. The data set used here for cross checking was made publicly available by PI S. R. Kulkarni. Portions of the results presented were based on observations obtained with *XMM-Newton*, an ESA science mission with instruments and contributions directly funded by ESA Member States and NASA, and with the *Chandra* X-ray Observatory. This research has made use of the NASA Astrophysics Data System (ADS) and the arXiv.