The mass of a millisecond pulsar

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ABSTRACT: We present spectroscopic and photometric observations of the optical counterpart to PSR J1911−5958A, a millisecond pulsar located toward the globular cluster NGC 6752. We measure radial velocities from the spectra and determine the systemic radial velocity of the binary and the radial-velocity amplitude of the white-dwarf orbit. Combined with the pulsar orbit obtained from radio timing, we infer a mass ratio of $M_{\rm PSR}/M_{\rm WD} = 7.36 \pm 0.25$. The spectrum of the counterpart is that of a hydrogen atmosphere, showing Balmer absorption lines up to H12, and we identify the counterpart as a helium-core white dwarf of spectral type DA5. Comparison of the spectra with hydrogen atmosphere models yield a temperature $T_{\rm eff} = 10090 \pm 150\,{\rm K}$ and a surface gravity $\log g = 6.44 \pm 0.20\,{\rm cm\,s^{-2}}$. Using mass-radius relations appropriate for low-mass helium-core white dwarfs, we infer the white-dwarf mass $M_{\rm WD} = 0.18 \pm 0.02\,M_\odot$ and radius $R_{\rm WD} = 0.043 \pm 0.009\,R_\odot$. Combined with the mass ratio, this constrains the pulsar mass to $M_{\rm PSR} = 1.40^{+0.16}_{-0.10}\,M_\odot$. If we instead use the white-dwarf spectrum and the distance of NGC 6752 to determine the white-dwarf radius, we find $R_{\rm WD} = 0.058 \pm 0.004\,R_\odot$. For the observed temperature, the mass-radius relations predict a white-dwarf mass of $M_{\rm WD} = 0.175 \pm 0.010\,M_\odot$, constraining the pulsar mass to $M_{\rm PSR} = 1.34 \pm 0.08\,M_\odot$. We find that the white-dwarf radius determined from the spectrum and the systemic radial velocity of the binary are inconsistent at the 1σ and 2σ level with the values that are expected if PSR J1911−5958A is associated with NGC 6752. We discuss possible causes to explain this inconsistency, but conclude that our observations do not conclusively confirm nor disprove the association of the pulsar binary with the globular cluster.