

# Discovery of an X-ray binary with a 22.45 hour period in M101

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Significant sinusoidal modulations with a best fit period of 22.45 hour have been discovered for an X-ray source CXO J140336.0+541925 in M101 from the M101 ultra-deep Chandra survey and an earlier observation. The phase has been preserved remarkably over a timeline of 5 years. The source had an average luminosity of about  $1e38$  erg/sec, but reached down to zero at the sine valleys in ten observations, suggesting a nearly edge-on viewing geometry. This period requires a B5V secondary and a 1.6 Msol primary, a B8V secondary and a 4 Msol black hole primary, or a B8V secondary and a 600 Msol black hole primary if the secondary is filling its Roche lobe. Alternatively, the binary could be a low mass black hole binary in its outburst phase with a less massive secondary not filling its Roche lobe, e.g., a G5V secondary half filling its Roche lobe and a 1.2 Msol neutron star or a 40 Msol black hole primary. Future telescopes such as JWST and GMT will be able to monitor the secondary and the accretion disk to determine the binary masses beyond doubt.