The Recurrent Nova U Scorpii in the 1999 Outburst: the First Detection of a Significant Orbital-Period Change

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abstract In this paper we present and discuss our time-resolved photometry of an eclipsing recurrent nova, U Sco, during an outburst in 1999, which was conducted from immediately after the optical maximum to the final fading toward the quiescence. In the first-ever complete light-curve, a few primary and secondary eclipses of the binary system were detected, and the timings of the minima were determined. We found that the eclipses showed no totality during the outburst. The depth of the primary eclipses was 0.4–0.8 mag, much shallower than that in quiescence. In the plateau phase, very little irradiation (≤ 0.1 mag) was observed in the orbital light curve, which implies the existence and a large flaring rim of the accretion disk during the outburst. The minima of the eclipses were detected at earlier orbital phases for the predicted ephemerides. Thus, we obtained an orbital period change of the binary system as \( \dot{P}/P = -1.7(\pm0.7) \times 10^{-6} \text{ yr}^{-1} \) from the \( O-C \). Assuming that this period change is a result of the conservative mass transfer between the component stars, its mass-transfer rate reaches \( \dot{M} = 2.4(\pm1.0) \times 10^{-6} \text{ M}_\odot \text{ yr}^{-1} \) for a 1.37 M\(_\odot\) white dwarf and a 2.0 M\(_\odot\) mass-donor companion, which is too high to cause shell flashes, even on a massive white dwarf. Therefore, this large rate of the period change strongly indicates a non-conservative mass transfer in the binary system.