PHOTOMETRY OF THE COMET 2060 CHIRON

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Since its discovery by C. Kowal at Palomar Observatory in 1977, the comet 2060 Chiron has proven to be an interesting and enigmatic object. Situated between the orbits of Saturn and Uranus, it was originally classified as the most distant asteroid. It began to show cometary behavior in 1987 by increasing a full magnitude in brightness and developing a coma; there is evidence for similar, earlier outbursts (Bus et al., 1989; Hartmann et al., 1990; Luu and Jewitt, 1990; Meech and Belton, 1990). The diameter of Chiron is ~200 km - larger than other well-observed comets - and it has a geometric albedo and spectrum similar to primitive C-type (carbonaceous chondritic) asteroids. A rotational light curve with a period of 5.92 days has been observed, although its amplitude decreased significantly during the recent outburst. Chiron's chaotic, inward evolving orbit provides evidence that it formed in the Oort cloud. A thorough study of Chiron is important for two reasons: 1) it is a transition object defining the relationships between comets, asteroids, and meteorites; and 2) a full description of its changes in brightness - particulary on time scales of hours - will provide an empirical foundation for understanding the physical mechanisms (including outgassing, sublimation of volatiles, and even significant mass ejections) driving the evolution of comets.

In early 1989 Chiron began to show a decrease in brightness. Short term outbursts were observed (Luu and Jewitt, A. J., 1990, in press), and on 1990 January 19, we observed with the Palomar 60-inch a rapid decrease in the brightness of Chiron's coma in the V and R filters (Buratti and Dunbar, 1991, see Figure). We also detected a rotational lightcurve of the nucleus with an amplitude only 1/4 that observed in its quiescent state: this fact indicates the increased importance of the optically thin coma to the observed brightness. Clearly, Chiron appears to be undergoing short term fluctuations in its brightness, as well as a general decrease associated with the demise of its coma. The short term changes may indicate outgassing events, rapid sublimation, or the escape of dust which is possibly electrostatically charged. The fact that no color changes to a 1% level were observed during the night - a period corresponding to an increasing importance of the nucleus in the detected signal - implies that the coma is laden with dusty material from the nucleus.

During the 1991 appariton 157 CCD images in the R filter were obtained over a period of two nights. No bursts of the sort seen in 1990 were observed; however the overall brightness of Chiron was about 25% brighter than last year (Marcialis et al., 1991). The amplitude of the light curve was about 0.04

magnitudes, twice as large as that observed last year, but only half that of its quiescent state (Bus et al., 1989)

Our strategy over the next two years will be to obtain CCD images with temporal resolution of 5-10 minutes in the V and R filters. Our specific measurement goals and scientific objectives are to 1) derive an absolute magnitude to tie our observations in with the secular (~months or year) decrease in Chiron's brightness; 2) detect and characterize short term (~ hours) outbursts or decreases in brightness and understand their cause(s); and 3) measure the light curve of the nucleus to monitor the growth and decay of the comet's coma and to understand the dynamical properties of the nucleus (e.g., whether it's precessing).

Because other comets, including Halley and Schwassmann-Wachmann I, have exhibited anomalous outbursts and declines in brightness (although none of the events have been observed with such photometric accuracy or temporal resolution as the Palomar work), this study is important for understanding the present nature and evolution of comets as a class.

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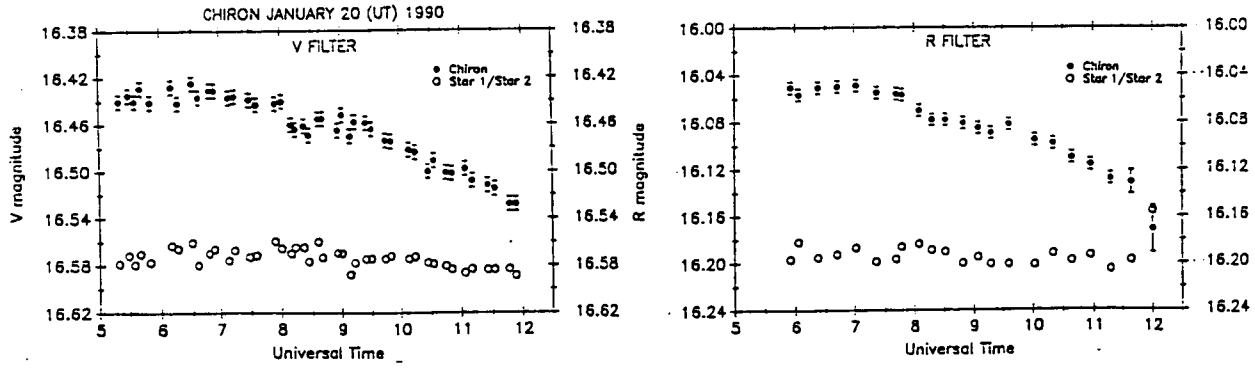

Figure. Palomar 60-inch observations of 2060 Chiron in the R and V filters. The ratio of two on-chip comparison stars used in our photometric reductions is also shown to demonstrate the certainty of the observations (Buratti and Dunbar, 1991)