a significantly different spectrum from that of NP 0532, but the present observation coupled with the MIT rocket results[5] rule out any continuous emission with a power-law spectrum. Second, the pulsar may be variable on longer time scales, but if this were true for a Crab-like spectrum definite limitations on long-term variability would be imposed by the lack of such variability within eight hours (the length of the present observations) and the failure to detect the pulsar seven days before and four days after the 30–100 keV observation. Third, it is also possible that the apparent 30–100 keV pulsation is not real, and confirmation of that result is needed, as well as spectral data in the 30–100 keV region.

Because the detector used for the present result was omnidirectional, the results also place an upper limit on any other periodic X-ray source in the region of the sky viewed. This upper limit corresponds to a flux at the top of the atmosphere of approximately 3×10^{-3} photons cm^{-2} s^{-1} in the 100–400 keV region, and applies to periods from 2 to 100 s for sources with right ascension between 2 and 14 h and declination between 0° and +60°.

We thank H. Friedman and T. A. Chubb for their support and comments. One of us (J. D. K.) was supported by the National Science Foundation.

JAMES D. KURFESS

E. O. Hulburt Center for Space Research,
Naval Research Laboratory,
Washington DC

MEIR MEIDAV

University of Tel-Aviv,
Tel-Aviv

DROR S. SADEH

E. O. Hulburt Center for Space Research,
and
University of Tel-Aviv

Received March 13, 1972.

[1] Sadeh, D., Meidav, M., Smathers, H. W., Chubb, T. A., and Friedman, H., *Nature*, **235**, 151 (1972).
[2] Kurfess, J. D., *Astrophys. J.*, **168**, L39 (1971).
[3] Smathers, H. W., Chubb, T. A., and Sadeh, D., *Nature*, **232**, 120 (1971).
[4] Blackman, R. B., and Tukey, J. W., *The Measurement of Power Spectra* (Dover, New York, 1958).
[5] Rappaport, S., Bradt, H., and Mayer, W., *Nature Physical Science*, **229**, 40 (1971).

Optical Counterpart of Cen X-3

WE wish to suggest the possibility that the X-ray source Cen X-3 may be identified with the Algol-type variable LR Cen, based on the proximity of their coordinates[1,2] and, more significantly, on the close coincidence of the orbital periods of the objects (2.08712 days for Cen X-3 (ref. 1) and 2.095595 days for LR Cen (ref. 2)). The 0.4% difference between the periods may well result from a change in period between 1930 and 1971 or from errors in the X-ray observations. The coincidence of the elements of LR Cen and Cen X-3 could be a proof of identity but unfortunately there have been no data obtained for LR Cen since 1930. Photometric and spectroscopic observations are urgently needed. Accepting that the observations are of the same system, we determine some of the characteristics of the system.

We used the mean photographic light curve based on observations made between 1922 and 1930 (ref. 2) to provide the photometric orbital elements. The light curve is symmetric, of the Algol type; the light intensity between eclipses is given by the expression: $l=1-0.03\cos\theta-0.02\cos^2\theta$. The secondary minimum occurs midway between primary minima, and the eclipses are partial. The normalized depths of the minima are 0.670 and 0.107.

The orbital elements were obtainable only for the occultation at the primary minimum. Using Russel's method (assuming circular orbit, thin atmospheres and uniform disks), we determined them as:

$$k=0.62,\ \alpha^0_{\max}=0.965,\ i=81^\circ\,05',\ \tau_1=0.352,\ \tau_2=0.218,\ L_1=0.305,\ L_2=0.695.$$

In deriving these elements we used only the slope and depth of the primary minimum and the depth of the secondary. Variables have their usual meaning (see, for example, ref. 2).

The width of the secondary minimum seems to be ~1.5 times larger than that of the primary minimum.

These results and the Uhuru data communicated to us by E. Schreier and colleagues lead to the following conclusions: Cen X-3 is a close binary system, its brighter and smaller component being connected with the X-ray source the minima of the intensity of the X-ray source are connected with absorption or scattering in the atmosphere of the more massive and relatively dark component; most probably, the mass of the dark component is 16 to 20 $M_\odot$ and its radius is $\sim7\ R_\odot$, that is, this is a main sequence O8–B0 star with surface temperature of $\sim25{,}000$ K; and the surface temperature of the brighter component must be $\sim250{,}000$ K, with the Rayleigh-Jeans region of the spectra of each component being observed.

It seems improbable that the whole spectrum is Planckian, because the total power of such radiation would be $L_2=10^{42}$ erg s^{-1} ($L_2=4\pi r_2{}^2\sigma T_2{}^4$, where $r_2\approx2.4\times10^{11}$ cm and $T_2\approx250{,}000$ K). This is evidently unacceptable.

So somewhere in the near ultraviolet the bright component becomes optically thin. It may be that a hot plasma shell surrounds the compact X-ray source. The optical depth for free-free transition at $\nu=10^{15}$ s^{-1} is ≈1, the mean N_e for the brighter component is $\sim10^{-12}$ cm^{-3} and the mass of the shell $\sim10^{23}$ g. These are rough estimates because physical conditions in the plasma shell depend on the distance from the X-ray source in its centre. Apparently the non-pulsating X-ray component originates in this shell from Compton scattering of the pulsating component of the radiation.

The brighter component of the radiation from Cen X-3 comes from a plasma, the temperature of which is determined by the X-ray absorption. We think it unlikely that this radiation is related to accretion of gas ejected from the B star onto the compact object. The B star is well inside its Roche limit and is nearly spherical. Most probably outflow of gas takes place from the compact X-ray source; our model of this source is therefore similar to the "double-component" model of Sco X-1 (ref. 3).

This young star may well lie in a spiral arm, and Cen X-3 may be in the Car-Sgr-Sct arm at a distance of 2 to 2.5 kpc, if $A_V\sim3$ mag. Nearby clusters in the same arm have A_V up to 2 mag (ref. 4). Perhaps the object is more distant, but in this case its X-ray luminosity must be essentially higher than that of NP 0532 (CM Tau).

JOSEF S. SHKLOVSKY
ANATOLY M. CHEREPASHCHUK
YURY N. EFREMOV

Space Science Institute,
Sternberg Astronomical Institute
Astronomical Council,
Moscow

Received March 23, 1972.

[1] Giacconi, R., Gursky, H., Kellogg, E., Schreier, E., and Tananbaum, H., *Astrophys. J. Lett.*, **167**, L67 (1971).
[2] Uitterdijk, F., *Bull. Astron. Insts. Netherlands*, **6**, 295 (1932).
[3] Shklovsky, J. S., *Astron. Zh.*, **48**, 1114 (1971).
[4] Becker, W., and Fenkart, R., *Astron. Astrophys. Suppl.* **4**, 241 (1971).