suggestion for explaining long-period pulsars has been put forward by Syunyaev.[16] The mechanism involving mass shedding under conditions such that $R_a < R_c$, in which gravitational attraction will predominate, cannot work. The principal cause of the retardation is the mechanism discussed above for the dissipation of rotational energy in the neighborhood of the magnetosphere boundary. Estimates show that the observed periods of all long-period pulsars correspond to P_{orb} = 6-10 days, $v \approx 10^8$ cm/sec, and $B_n = (0.3\text{-}10) \cdot 10^{12}$ gauss.

The rotation of the long-period pulsars GX 1 + 4 and GX 301 + 0 is known to be accelerating strongly[17,18] and their periods are rapidly becoming shorter: $P/\dot{P} = 10^9$-10^{10} sec. This effect evidently results from changing accretion conditions, such as a transition from a nearly radial to a disk regime.[2)] One would expect that as a by-product of this acceleration intense streams of soft x rays would be emitted in the vicinity of the magnetosphere boundary, at a power of 10^{35}-10^{36} erg/sec.

The author is grateful to Yu. N. Gnedin, A. Z. Dolginov, L. M. Ozernoi, R. A. Syunyaev, and A. I. Tsygan for useful discussions of the topic and valuable comments.

1)This has been pointed out by R. A. Syunyaev.
2)An interpretation of this kind has been suggested by A. I. Tsygan.

[1]S. Shulman, H. Friedman, G. Fritz, R. C. Henry, and D. J. Yentis, "Soft x-ray emission from Her X-1," Astrophys. J. 199, L101-L104 (1975).
[2]R. C. Catura and L. W. Acton, "Intense soft x-ray flux from Her X-1," Astrophys. J. 202, L5-L7 (1975).
[3]J. Heise and A. C. Brinkman, "ANS results on x-ray binaries," in: X-Ray Binaries (proc. Goddard Space Flight Cen. Sympos., Oct. 1975), NASA SP-389 (1976), pp. 27-47.
[4]J. A. M. Bleeker, A. J. M. Deerenberg, K. Yamashita, S. Hayakawa, and Y. Tanaka, "Observations of soft x-ray emission from Cen X-3 below 2 keV," Astrophys. J. 183, L1-L3 (1973).
[5]B. Margon, K. O. Mason, F. J. Hawkins, and P. W. Sanford, "Soft x-ray observations of Cen X13 from Copernicus," Astrophys. J. 196, L51-L53 (1975).
[6]R. Doxsey, G. Jernigan, D. Hearn, H. Bradt, J. Buff, G. W. Clark, J. Delvaille, A. Epstein, P. C. Joss, T. Matilsky, W. Mayer, J. McClintock, S. Rappaport, J. Richardson, and H. Schnopper, "X-ray nova A0620 − 00: celestial position and low-energy flux," Astrophys. J. 203, L9-L12 (1976).
[7]M. I. Basko and R. A. Syunyaev, Preprint Inst. Kosmich. Issled. Akad. Nauk SSSR No. 276 (1976).
[8]R. McCray and F. K. Lamb, "An opaque shell around Her X-1?," Astrophys. J. 204, L115-L118 (1976).
[9]N. I. Shakura, "The long-period x-ray pulsar 3U 0900 − 40 as a neutron star with an abnormally strong magnetic field," Pis'ma Astron. Zh. 1, No. 11, 23-28 (1975) [Sov. Astron. Lett. 1, 223-225 (1976)].
[10]A. F. Illarionov and R. A. Syunyaev, "Why is the number of galactic x-ray stars so small?," Astron. Astrophys. 39, 185-195 (1975).
[11]N. I. Shakura and R. A. Syunyaev, Preprint Inst. Priklad. Matem. Akad. Nauk SSSR No. 28 (1972).
[12]G. Fritz, S. Naranan, S. Shulman, D. J. Yentis, H. Friedman, A. Davidsen, R. C. Henry, and W. Snyder, "Soft x-rays from Her X-1 during the 'off' state," Astrophys. J. 207, L29-L32 (1976).
[13]M. Milgrom, "Spectroscopic properties of HZ Her in model calculations," Astrophys. J. 206, 869-875 (1976).
[14]J. B. Hutchings, "Light curves and masses of Cyg X-1, SMC X-1, and Cen X-3," Astrophys. J. 193, L61-L63 (1974).
[15]E. J. Schreier, K. Swatz, R. Giacconi, G. Fabbiano, and J. Morin, "The long-term intensity behavior of Cen X-3," Astrophys. J. 204, 539-547 (1976).
[16]R. A. Syunyaev, Preprint Inst. Kosmich. Issled. Akad. Nauk SSSR No. 270 (1976).
[17]R. H. Becker, E. A. Boldt, S. S. Holt, S. H. Pravdo, R. E. Rothschild, P. J. Serlemitsos, and J. H. Swank, "Spectral variability in the x-ray pulsar GX 1 + 4," Astrophys. J. 207, L167-L169 (1976).
[18]N. E. White, K. O. Mason, H. E. Huckle, P. A. Charles, and P. W. Sanford, "Periodic modulation of three galactic x-ray sources," Astrophys. J. 209, L119-L124 (1976).

Conspicuous changes in the shape of two cometary nebulae

A. L. Gyul'budagyan, T. Yu. Magakyan, and A. S. Amirkhanyan

Byurakan Astrophysical Observatory, Academy of Sciences of the Armenian SSR

(Submitted November 30, 1976)
Pis'ma Astron. Zh. 3, 162–164 (April 1977)

Pronounced variability is reported in two cometary nebulae, one of which has not previously been known.

PACS numbers: 98.40.−p

It has long been known that certain cometary nebulae, particularly Hubble's nebula (NGC 2261) and Hind's nebula (NGC 1555), are variable. Probably variability is not an especially rare phenomenon among cometary nebulae. Nevertheless, the two examples described below − nebulae that we have identified with the new 2.6-m reflector of the Byurakan Astrophysical Observatory − show unusually striking changes.

An extremely interesting object is No. 29 on our list of new cometary nebulae [$\alpha = 20^h45^m.4$, $\delta = 67°46'$ (1950.0)]. It is located in the dark nebula Khavtasi 166, about 1°.5 west of the nebula NGC 7023, and is shown in Fig. 1, reproduced from the red Palomar Sky Survey print (wavelength range 6000-6700 Å). In the Palomar atlas this object is shaped like a narrow band, neutral in color and ≈ 1' long. About 30" southwest of the southern end of this band there is a faint (≈ 18^m on the red print) red star. The star is scarcely perceptible on the blue print. North of the star, on the side toward the band, one can just discern traces of a very faint fan-shaped nebula, also of neutral color. Evidently the light of the star is strongly absorbed.

Using the 2.6-m Byurakan reflector we have photographed the object in the blue−violet (Zu-2 emulsion, 20-min exposure, 1976 Aug 29) and yellow−red regions (103a-F emulsion + ZhS-12 filter, wavelength range 4500-6700 Å, 40-min exposure, 1976 Sep 28). The latter photograph is reproduced in Fig. 2. These pictures show that the streak has completely disappeared, but the broad fan north

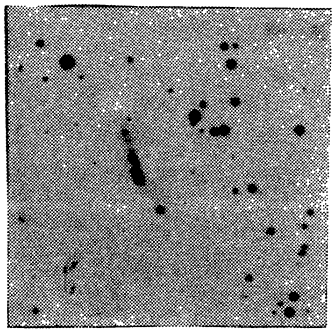

FIG. 1. Cometary nebula No. 29. Red Palomar Sky Survey print.

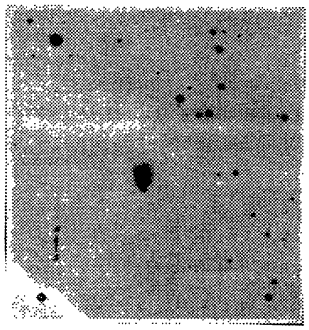

FIG. 2. Cometary nebula No. 29. Red 2.6-m Byurakan telescope photograph.

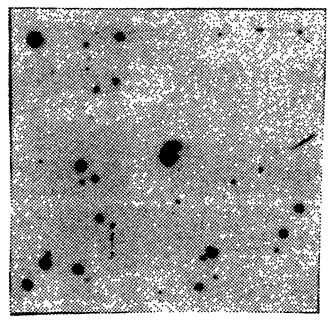

FIG. 3. A cometary nebula in Cygnus. Red Palomar Sky Survey print.

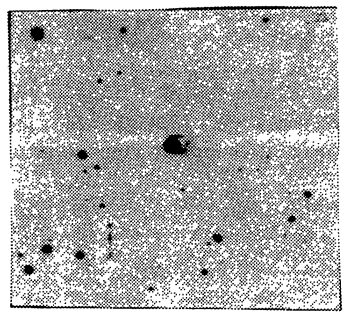

FIG. 4. A cometary nebula in Cygnus. Red 2.6-m Byurakan telescope photograph.

of the star has become very bright. The star proves to be situated almost exactly at the tip of the fan and is visible only in the red photograph, whereas the fan is approximately neutral in color. Upon comparison with the surrounding stars we find that the brightness of the star is practically unchanged from its image in the Palomar atlas. A search of the Byurakan plate collection reveals that in 1968-1970 the region around NGC 7023 was photographed in an effort to find flare stars. Plates kindly supplied by Parsamyan and Erastova show that the fan was already quite bright, and at the site of the band one can distinguish a very faint trace.

We are in effect dealing, then, with the formation of a new cometary nebula shaped like a cone (type II), remarkably similar to the prototype NGC 2261. To interpret this phenomenon, further and more detailed observations are called for.

The second variable object is a cometary nebula associated with a star which might be an FU Orionis object, or "fuor."[2] In the Palomar atlas it has the appearance of a star with a fairly bright comma-shaped nebula extending from it in a northerly direction; it has been classified previously[3] as a cometary nebula of type III. Very faint traces of the nebula are also perceptible to the west of the star. The object is appreciably brighter on the red Palomar print; its position is $\alpha = 20^h20^m.3$, $\delta = 41°53'$ (1950.0).

With the 2.6-m Byurakan telescope we have taken a series of photographs of the object in various wavelength ranges, and have detected a pronounced change in the shape of the nebula. For comparison, Figs. 3 and 4 show on the same scale images of the object on the red Palomar print and on one of our plates, taken 1976 Aug 19 (103a-F + ZhS-12, 45-min exposure).

The bright southwestern branch of the nebula is a conspicuous feature. It now resembles a ring 16-17" in diameter, and the star is on the east side. The west side of the ring, opposite to the star, is somewhat broader and more diffuse. Faint traces of the nebula can be discerned even farther westward. The general appearance of the nebula is similar in different colors, but the details are best seen in the photograph taken in the yellow–red spectral region.

Curiously, despite the changes observed, the star has exhibited no appreciable brightness fluctuations. On the basis of a comparison that has been made[2] with the B magnitudes of neighboring stars, we estimate its brightness to be $\approx 13^m.0$.

There is evidence that the change in the form of the nebula occurred no earlier than 1964, because on a photograph of this region taken by Khachikyan with the 1-m Schimdt telescope of the Byurakan Astrophysical Observatory on 1964 Dec 1 (IIa-F + GG II, 50-min exposure) the object has exactly the same shape and size as in the Palomar atlas.

[1]A. L. Gyul'budagyan and T. Yu. Magakyan, "New cometary nebulae," Pis'ma Zh. 3, 113-116 (1977) [Sov. Astron. Lett. 3, 58 (1977)].
[2]W. Wenzel and H. Gessner, "Neuer veränderlicher Stern mit Nebelanhang," Mitt. Veränderl. Sterne (Zentralinst. Astrophys., Sonneberg) 7, 23-24 (1975).
[3]M. Cohen, "Infrared observations of new cometary nebulae," Publ. Astron. Soc. Pacific 86, 813-819 (1974).