

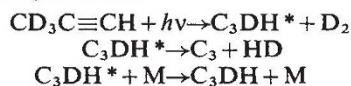
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Origin of C₃ in Comets

SEVERAL plausible parent molecules may be proposed for cometary species such as H, OH, C₂, CN and so on, but no parent molecule has been shown to produce C₃ by primary photodissociation without the intervention of secondary collisions. Swings¹ has considered the possibility that the parent molecule is diacetylene (H—C≡C—C≡C—H), and Callomon and Ramsay² have observed C₃ in absorption in the flash photolysis of diacetylene diluted with a high pressure of He. They suggest that the primary process may be C₄H₂ + *hν* → C₃H + CH followed either by decomposition of C₃H to C₃ + H or by reaction of C₃H with CH to form C₃ + CH₂. The first alternative does produce C₃ without secondary collisions, but it could not be responsible for the observations in the flash photolysis experiments in a quartz vessel because the overall process C₄H₂ → C₃ + H + CH is not energetically possible above approximately 1057 Å (ref. 3). An additional complication is that product analysis from the continuous photolysis of diacetylene has led to the suggestion⁴ of primary processes such as C₄H₂ + *hν* → C₂H₂ + C₂ and C₄H₂ + *hν* → 2 C₂H, although C₂ was not seen in absorption in the flash photolysis experiments in isothermal conditions².

Gausset *et al.*⁵ have raised the possibility of the parent molecule for C₃ being propane (C₃H₈) or propylene (C₃H₆) from which all H atoms have been removed by photodissociation. There is no evidence from laboratory work on the photolysis of either propane or propylene relating to this suggestion⁶. Here, I point out that recent evidence from several sources suggests that the related molecule propyne (CH₃C≡CH) should be given serious consideration as a potential source for C₃ in comets. Propyne is a relatively volatile compound and the simplest stable hydrocarbon containing three carbon atoms.

Recent results⁷ on the photolysis of propyne at 1236 Å show that hydrogen is formed exclusively through a molecular process. Photolysis of CD₃C≡CH yields equal amounts of D₂ and HD; the addition of inert gas reduces HD relative to D₂. I take these observations as evidence for a contribution from the following reactions



An alternate possibility is the occurrence of two simultaneous primary processes giving equal yields of hydrogen from the same carbon (D₂) as from the terminal carbons (HD). The reduction of HD relative to D₂ with increasing pressure makes this explanation unlikely because pressure is not likely to affect the relative importance of two simultaneous primary processes in photolysis with monochromatic light. Although collisional deactivation of the C₃DH intermediate occurs in the laboratory experiments, the overall process at low pressures for the non-deuterated species may be written as C₃H₄ + *hν* → C₃ + 2H₂.

I therefore suggest that a potential source of C₃ in comets is the photodissociation of propyne by solar radiation, most

probably in the region of the strong 1216 Å Lyman-α line. Although the overall process C₃H₄ → C₃ + 2H₂ is energetically possible below 1961 Å (ref. 8), a more energetic photon may be required if H₂ carries off some of the available energy.

This tentative suggestion becomes more interesting in the light of the recent discovery of propyne (methylacetylene) in interstellar space⁹. It is an attractive, although by no means established, possibility that there is a strong correlation between interstellar molecules and the stable parent cometary molecules.

Finally, I emphasize that comparable processes may occur in the photodissociation of molecules related to propyne (for example, allene, CH₂=C=CH₂) but there is no experimental evidence presently available. An attempt to detect C₃ by absorption spectroscopy in the vacuum-ultraviolet flash photolysis of propyne or allene would clarify the situation.

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Optical Polarization of X Per

It has been suggested that the variable star X Per may be the X-ray source 2ASE 0352 + 30 (refs. 1 and 2, and R. J. Brucato and J. Kristian, personal communication). Nikulin *et al.*³ report strong and variable circular polarization of Sco X-1 and HD 226868 (the possible optical counterpart of Cyg X-1), so the polarization of X Per (and its variation) is of interest. One of us (J. T., unpublished thesis) has recently developed a wide-band polarization modulator of the Dollfus type^{4,5}. A prototype using plastic retarders was used on a 30-cm Cassegrain reflector to observe the polarization of nearby bright stars, and of ζ Per and X Per. The observations on bright stars and on ζ Per show that instrumental polarization (linear or circular) is certainly less than 0.02% of the total intensity, even in the presence of several % of total intensity in polarization forms other than that being measured. Our bandwidth of approximately 1000 Å is centred between 5000 Å and 5500 Å.

We observed X Per in circular polarization on February 4 and 5, 1972. The observations are photon limited. All individual 10 min integrations yield a degree of circular polarization of less than 0.05%. If we assume the degree of circular polarization of X Per to be constant, we may average all the observations. With this assumption, and remembering the upper limit on instrumental polarization, we deduce that the degree of circular polarization of X Per is less than about 0.02%.

From sporadic observations we are not completely satisfied that the linear polarization of X Per is constant, but we cannot prove variability. The average value we obtain lies between those quoted by Behr⁶ and Hiltner⁷.