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N91-14224

CURRENT STAR FORMATION IN S0 GALAXIES: NGC 4710

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Elliptical (E) and lenticular (S0) galaxies lack the substantial interstellar medium found in the star-forming spiral galaxies. However, significant numbers of E and S0 galaxies are known to contain detectable amounts of interstellar matter (e.g., Jura 1988). Thus, it is worth investigating whether these galaxies are currently able to form stars from their ISM, or whether they should truly be consigned to the 'dustbin of inert objects' (Thronson and Bally 1987).

NGC 4710, an edge-on S0 in the Virgo Cluster, is a particularly promising candidate for study. It is known to be relatively dusty, as indicated by its Hubble subtype of S0₃ (Fig. 1; Sandage 1961) and its substantial far infrared power of 2×10^{36} W (Knapp *et al.* 1989) for an assumed distance of 20 Mpc. An elongated kiloparsec-scale radio continuum source resides in NGC 4710's nucleus (Fig. 2; Wrobel and Heeschen 1988) and is aligned with the galaxy's edge-on stellar disk. The radio source has a steep spectrum (Wrobel, Briggs, and Heeschen, in preparation). Steep radio spectra and radio-optical alignments are properties shared by the radio sources in flattened spiral galaxies thought to be undergoing rapid star formation (Condon *et al.* 1982). Supernova remnants produced at a rate of $\sim 0.3 \text{ yr}^{-1}$ could account for NGC 4710's observed radio power. Furthermore, NGC 4710 conforms to the radio versus far infrared relation defined by star-forming galaxies (Wrobel and Heeschen 1988; Walsh *et al.* 1989).

The results cited above strongly imply that current star formation is responsible for NGC 4710's far infrared and radio continuum properties. If this is indeed the case, then one expects this star formation to be fueled by molecular gas, which is presumably dominated by H₂ and can be traced by the ¹²CO J = 1 → 0 line. Both Kenney and Young (1988) and Sage and Wrobel (1989) see Fig. 3) have detected such an emission line from NGC 4710, and infer the presence of more than $10^8 M_{\odot}$ of H₂.

10 (exp 8) solar mass of H2, CO-12 J=1 to 0 line

The origin of the molecular gas in NGC 4710 remains a mystery. The galaxy is very deficient in HI (Kenney and Young, in preparation), suggesting that it originally was a spiral galaxy from which the outer, mainly atomic, gas was stripped by the ram pressure of the Virgo Cluster's intracluster medium, leaving only a central ISM rich in molecular gas. Alternatively, the CO may have originated via stellar mass loss with subsequent cooling, cooling flows, or capture from a gas-rich companion. Information on the morphology and kinematics of the CO can be compared with that of the galaxy's other gases and stars to distinguish among these various possible origins for the molecular gas. Major axis CO mapping with single dishes indicate an unresolved source (FWHM $\leq 45 - 55'' \sim 5$ kpc). Thus, the OVRO Millimeter Array is currently being used to image NGC 4710 in CO to provide the needed morphological and kinematical data. (Wrobel and Kenney, in preparation).

Wrobel and Kenney, in preparation
(1989)

In conclusion, studies of NGC 4710 provide compelling evidence that stars are currently forming in this S0's interstellar medium. Imaging of the molecular gas that fuels the current star formation should offer important insight into the origin of this newly discovered phase of the interstellar medium of S0 galaxies.

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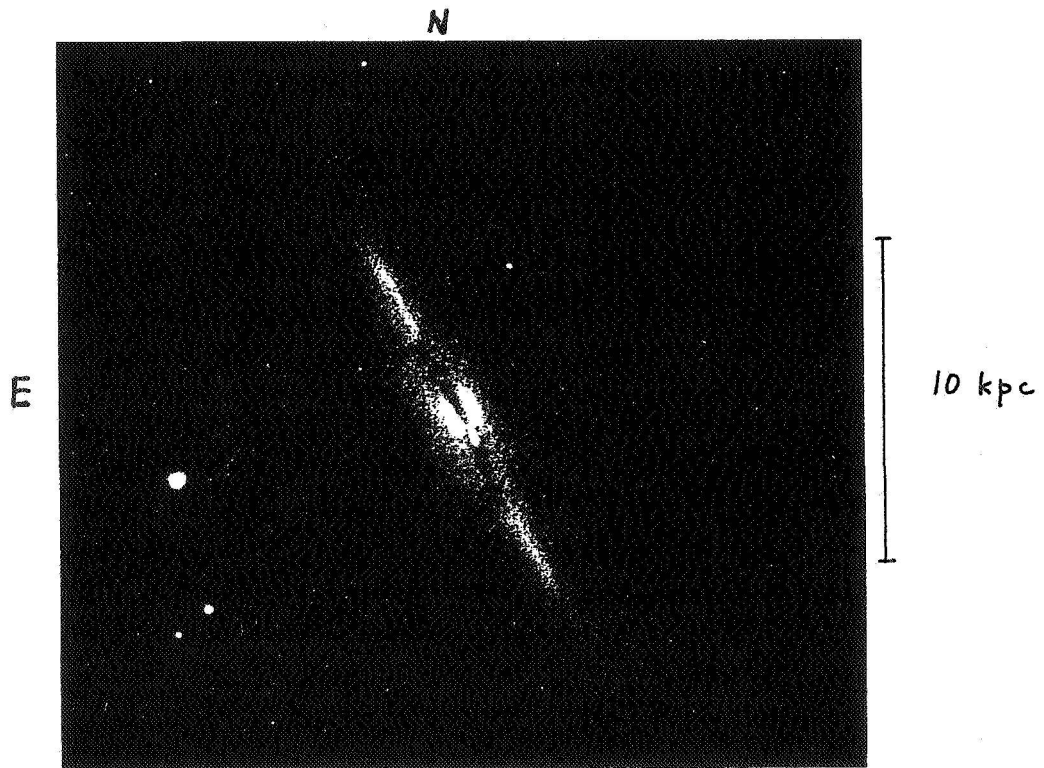


Fig. 1. - Reproduction of NGC 4710 from plate 6 of Sandage (1961).

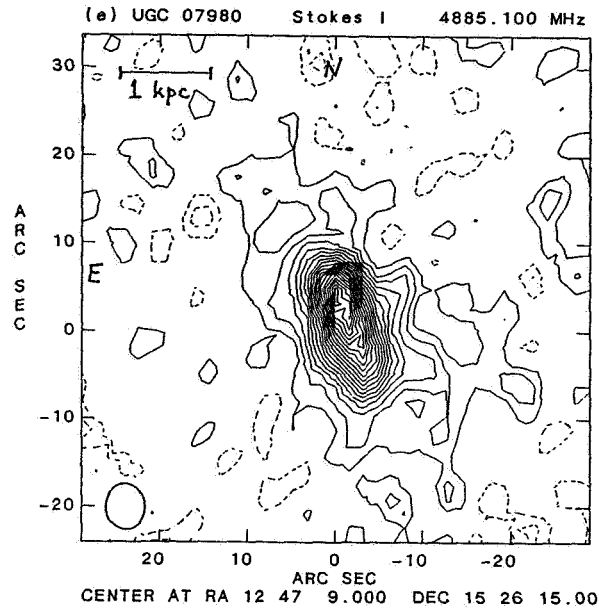


Fig. 2. - VLA 6-cm image of the inner regions of UGC 07980 = NGC 4710 (Wrobel and Heeschen 1988). Origin is at optical position (Dressel and Condon 1976; $\pm 4''$). Contour interval is $0.1 \text{ mJy beam}^{-1}$. Contours at integral levels between -4 and $+20$ are shown. Ellipse in south-east corner shows restoring beam orientation and size at FWHM. Power at 6 cm is $4 \times 10^{20} \text{ W Hz}^{-1}$.

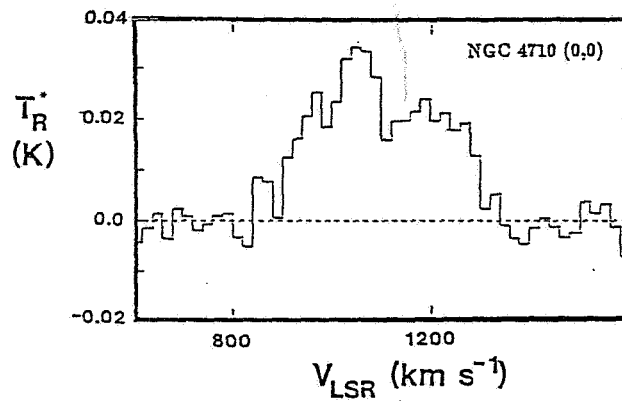


Fig. 3. - $^{12}\text{CO } J = 1 \rightarrow 0$ line from NGC 4710 (Sage and Wrobel 1989).