This uncertainty should be even more pronounced in comparing the frequency of the *G. menardii* complex in tropical Atlantic cores with temperate to subtropical South Pacific cores, since these forms have a more restricted distribution than the *N. dutertrei* group (*9, 10*).

The doubtful significance of correlations based on the *G. menardii* complex in areas outside its typical habitat can be demonstrated by examination of two cores from the Mozambique Channel, Indian Ocean. The area is in a planktonic province comparable with that of Ericson and Wollin's (*1*) cores. Vincent (*12*) has convincingly shown that the Pleistocene-Holocene boundary can be defined in the Mozambique Channel by the significant decrease in relative abundance of the temperate species *Globorotalia inflata* (d'Orbigny), from over 20 percent of the planktonic foraminiferal fauna below the boundary to less than 5 percent above it (Fig. 2). If the frequency technique of Ericson and Wollin (*8*) is used, the ratios obtained are between 3 and 6 below the boundary and under 0.5 above it (Fig. 2). Reversed trends are shown by most warm water species, such as *Globigerinoides conglobatus* (Brady), *G. sacculifer* (Brady), *N. dutertrei dutertrei*, and *Pulleniatina obliquiloculata* (Parker and Jones), supporting the evidence for a warm water influx. Analysis of the *G. menardii* complex (Fig. 2) shows, however, an increase of the complex below the boundary in core 361 F, whereas no definite trend exists in core 361 J. If this evidence is considered alone, without study of the total fauna, a cooling above the boundary would be suggested, in opposition to the actual situation. These contradictory findings are of the same kind and magnitude (Fig. 2) as those of Ericson and Wollin (*1*).

It might be assumed that selective solution of foraminiferal tests could create these opposing trends, in light of the latest information regarding carbonate solution and the lysocline position (*10, 13*). As shown in Fig. 2, however, the frequency of *Globigerinoides ruber* (d'Orbigny), a temperate to tropical species highly susceptible to solution (*10*), does not decrease below the boundary.

In conclusion, correlation attempts based solely upon the *G. menardii* complex in cores from different water masses, especially those of marginal tropical areas, are of questionable value. This fact, in addition to previous reports showing correlation between Quaternary cores of the Atlantic and the Pacific oceans, indicates that the Pleistocene climatic history of the two oceans was not opposed but parallel.

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X-ray Survey of Centaurus A

Abstract. An x-ray survey of Centaurus A has given marginal evidence of its x-ray flux. If taken as an upper limit on inverse Compton x-rays generated by scattering interactions between relativistic electrons and cosmological background photons, the observation implies an upper limit of close to 3°K for the background radiation temperature.

Centaurus A, at a distance of about 4 megaparsecs, is the nearest of the powerful radio galaxies. It is also one of the most extended radio nebulas, and this feature, combined with its nearness, gives it a large extent in the sky. Radio astronomers have been able to resolve its structure in some detail, both for intensity distribution and polarization. The radio galaxy consists of two double sources: an extended pair separated by a distance of 240 kiloparsecs and covering a spread of at least 600 kiloparsecs, and a pair of components whose projections fit within the dimensions of the optical galaxy. Both halves of the extended source are nearly symmetrical, although the northern lobe has a slightly higher peak intensity. Figure 1 shows the contour pattern of radio intensity with the contribution of the central source removed. Over most of the extended source, the polarization pattern is fairly uniform and there is no significant evidence of complex irregularities in the magnetic field.

Shklovsky (*1*) has pointed out that an x-ray survey of Centaurus A could be made with sufficient resolution to permit one to identify emission from the extended source as distinct from that of the central region. The angular separation of peak emission centers in the extended double source is about 3 degrees, so that the respective contributions of the north and south lobes could, in principle, be separated from that of the central source with 1-degree collimation of the x-ray receptor. Shklovsky emphasized that any observable x-ray emission from the extended source would need to be produced by inverse Compton scattering of the 3°K background radiation. A measurement of the Compton x-ray flux could place significant limits on the microwave background radiation, the ratio of relativistic electrons to protons, and the strength of the magnetic field in the radio plasma.

In April 1968, we flew an Aerobee rocket carrying two proportional counters equipped with a 1 degree by 8 degree field of view. Each counter had a thin film Mylar window, ⅛ mil in thickness, and was sensitive to x-rays from about ¼ to 10 kev. The rocket was stabilized and programmed to scan the radio source slowly from north to south. To determine the direction of view, a series of star field photographs was made during the progress of the scan. Unfortunately, certain mechanical malfunctions of the protective door system marred the performance of the aspect camera and of one of the counters. Reliable aspect data were obtained only after 172 seconds from the time of launch. The track of the scan is indicated on Fig. 1 as determined by successive star field photographs at 5-

Table 1. Counts accumulated during scan intervals centered on possible x-ray sources in Centaurus A.

Potential x-ray source	Duration of centered interval (seconds)				
	6	8	10	32	40
Optical galaxy	251	331	415	1308	1642
Northern radio max.	251	348	420		
Southern radio max.	232	302	379		

Table 2. Standard deviation* of count accumulation during scan intervals centered on possible x-ray sources in Centaurus A.

Potential x-ray source	Duration of centered interval (seconds)				
	6	8	10	32	40
Optical galaxy	1.40	1.40	1.63	2.35	2.81
Northern radio max.	1.40	2.38	1.89		
Southern radio max.	0.14	−0.23	−0.21		

* Based on an average count over the total interval (113.0 to 271.0) = 38.3 count/sec.

second intervals. The center of the slit-shaped field of view tracked close to the north-south line through the center of the galaxy at a rate of about 0.1 degree/sec. The following analysis is based on counting rates observed with the one counter whose operation was not compromised by any uncertainty about its door being fully opened. The effective aperture of that counter was 260 cm^2.

The counting rates were too low to permit us to resolve any statistically significant x-ray emission contours. However, by integrating larger intervals of scan, we obtained useful results. From 113 to 271 seconds, the detector tracked from declination −36 degrees to −52 degrees. Over this entire scan, including the radio source, the average count rate was 38.3 count/sec, and we take this value to be the general background, with both unrejected counts from cosmic ray particles and diffuse background x-rays included. Tables 1 and 2 show weak evidence of x-ray flux over a broad interval, containing the central source region slightly north of the optical galaxy. The largest signal-to-noise ratio, 3.2 σ, was obtained for the 20-second interval from 162.0 to 182.0 seconds, which covered roughly half the northern lobe up to the optical galaxy. For the corresponding interval on the southern side of the optical center (182.0 to 202.0 seconds), the x-ray signal was only 0.8 σ. In the entire interval from 162.0 to 202.0 seconds (centered about the optical galaxy) which includes most of the extended radio source, the average count rate was 2.7 count/sec, or 0.010 count cm^{-2} sec^{-1} (2.8 σ). If we take the distance to Centaurus A to be 3.8 megaparsecs and assume a spectral energy index of −1, we obtain for the x-ray luminosity

$$L_{\mathrm{XR}\ (1\ \mathrm{to}\ 10\ \mathrm{kev})} = (1.1 \pm 0.4)\ 10^{41}\ \mathrm{erg/sec}$$

The theory of synchrotron radiation from radio galaxies relates the observed power and spectral index to the energy density of relativistic particles and the magnetic field. Simplifying assumptions are made that the absolute value of the magnetic field strength and the relativistic electron concentration are approximately constant over the volume of the source. For a known distance to the source and an observed emission flux, the total energy of relativistic electrons in the source can be determined if the magnetic field strength H is known. However, there are no direct measurements of magnetic field available. Therefore, it is generally assumed that equipartition exists between the total energy content of relativistic particles and the energy of the magnetic field, W_{H}; that is,

$$W_{\mathrm{H}} = W_{\mathrm{CR}}$$

where W_{CR} is the total energy of cosmic ray nucleons and electrons in the radio nebula. A remaining unknown is

Table 3. Values listed by Ginzburg and Syrovatsky (*2*) for Centaurus A.

Distance R	= 3.8 megaparsecs
Spectral index α	= 0.77 (10^7 to 10^9 hz)
Flux F_ν (10^8 hz)	= 7.6×10^{-23} watt m^{-2} hz^{-1}
Radio power	= 1.3×10^{41} erg/sec (10^7 to 10^9 hz)
Magnetic field H	= 4 microgauss
W_{CR}	= 1.7×10^{59} ergs
k	= 100

the ratio k of W_{CR} to the energy of electrons, W_{e}. From evidence of cosmic ray observations near the earth, k is usually taken to be ~ 100. This ratio has a large measure of uncertainty and in some sources is believed to be very low (Virgo A) or possibly $\lesssim 1$ (Crab Nebula) (*1*).

For Centaurus A Ginzburg and Syrovatsky (*2*) list the values given in

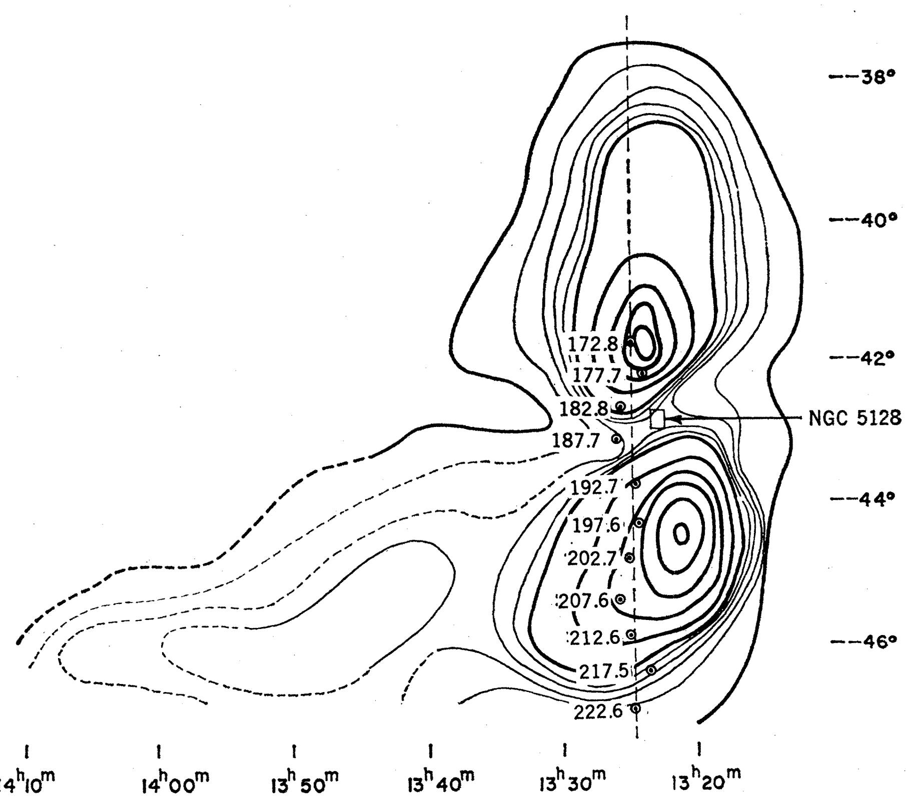

Fig. 1. Dashed line shows track of x-ray scan across radio galaxy Centaurus A. Contours map the extended radio source (*5*), with the contribution of the small central source associated with the immediate vicinity of the galaxy NGC 5128 omitted. Times after launch are indicated at positions of the center of the x-ray field of view along the scan track.

Table 3. The flux listed in Table 3 applies to the two extended radio nebulas, exclusive of the central source. It was assumed that W_e is 1 percent of W_{CR}. The characteristic energy of relativistic electrons responsible for synchrotron radiation at 10^8 hz is given by

$$100 \text{ Mhz} = 4.2 \times 10^{-6} \gamma^2 H_\perp$$

where $H_\perp$ is in microgauss and γ, the ratio of relativistic electron energy to the electron rest mass, is given by

$$\gamma = \frac{E}{mc^2}$$

For $H_\perp = 4$ microgauss, $\gamma = 2.5 \times 10^3$ and $E \approx 10^9$ ev.

GEV electrons in a 2.7°K radiation field will produce x-rays by inverse Compton scattering in the energy range

$$E_{XR} \text{ (ev)} = 3.1 \times 10^{-4} \gamma^2 T \text{ (°K)} = 5000 \text{ ev}$$

which is the middle of the observed soft x-ray band (1 to 10 kev).

The power P of inverse Compton scattering per electron is

$$P = 2.7 \times 10^{-14} \gamma^2 \rho_{ph}$$

where ρ_{ph} is the energy density of photons whose wavelength is $\sim$ 1 mm. For a radiation background temperature of 2.7°K,

$$\rho = 4 \times 10^{-13} \text{ erg/cm}^3$$

The total number of 10^9-ev electrons, on the basis of Ginzburg and Syrovatsky's value of

$$W_{CR} = 1.7 \times 10^{59}$$

and $k = 100$, is about 1.1×10^{60}. Accordingly, the total x-ray power, L_{XR} (Compton), should be 5×10^{40} erg/sec. This computed value is to be compared with the observed flux,

$$L_{XR} \text{ (obs)} = (1.1 \pm 0.4) \times 10^{41} \text{ erg/sec}$$

If the observed x-ray flux included an appreciable contribution from the central radio source, L_{XR} (extended source) should be somewhat lower for comparison with the theoretical Compton flux. In any case, the x-ray upper limit is consistent with a 3°K background. Shivanandan, Houck, and Harwit (*3*) have reported a flux of 5 $(+5, -2.5) \times 10^{-9}$ watt cm^{-2} steradian^{-1} in the band from 0.4 to 1.3 mm, which corresponds to $\rho_{ph} \approx 13$ ev/cm^3. For 2.7°K, the photon energy density is 0.25 ev/cm^3. The possible 50-fold infrared excess observed by the rocket instrument and a similar result recently obtained with a balloon-borne instrument (*4*) are inconsistent with the x-ray observation and the prediction of the radio model.

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Induced Photolysis of DDT

Abstract. *Photolysis of mixtures of certain alkyl halides and aromatic amines produces dehalogenation of the halide. These reactions involve a photoinduced charge transfer from the amine to the halide. Photolysis of tritolylamine and carbon tetrachloride produces tritolylaminium chloride. Photolysis of 1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)ethane (DDT) and diethylaniline at 3100 angstroms yields 1,1-dichloro-2,2-bis(*p*-chlorophenyl)ethylene (DDE), 1,1-dichloro-2,2-bis(*p*-chlorophenyl)ethane (DDD), *p,p′*-dichlorobenzophenone (DDCO), and hydrogen chloride. Photolysis of DDT does not occur unless an inducer which has a low ionization potential, such as diethylaniline, is present. The DDT-diethylaniline mixture is stable in the dark, and the induced photolysis is not affected by triplet quenchers.*

The pervasiveness of halogenated pesticides is a result of the resistance of these compounds and their progeny to environmental degradation. Utilization of solar energy is one approach to the decomposition of these compounds and, indeed, the photolysis of DDT (*1*) and of a number of other pesticides (*2*) has been studied. It is unfortunate that chlorinated hydrocarbons do not have a higher extinction coefficient ε in the solar region since this would undoubtedly lead to environmental photodegradation. An alternative approach is to induce their decomposition with other compounds which do absorb in the solar region. We report here on such a process and its application to DDT. This information may be useful for designing insecticides and understanding the environmental chemistry of such compounds.

This process involves the use of a sensitizer which is first photoexcited and then transfers an electron to organic halides. This should produce dissociation of the organic halide in analogy with a large number of chemical reactions of the type (*3*)

$$A \xrightarrow{h\nu} A^*$$

$$A^* + RCl \longrightarrow A^{+\cdot} + R\cdot + Cl^-$$

The photo-ionization of aromatic amines is a related process. Kadogen and Albrecht have, for example, studied the ionization of tetramethyl phenylenediamine in some detail (*4*). Hammill and co-workers (*5*) have recorded numerous examples of this phenomenon in glasses. They have also used alkyl halides to scavenge the dissociated electrons. Two closely related photoreactions have been studied in solution. While this study was in progress Tosa *et al.* (*6*) reported that dimethylaniline photolyzed in the presence of chlorobenzene produced benzene, biphenyl, and *N*-methylaniline. An excited charge-transfer complex was proposed as the critical intermediate. The photoinitiated reaction between carbon tetrachloride and primary aliphatic amines has received considerable attention (*7*). It has been proposed that in this case photolysis of a ground-state charge-transfer complex initiates a radical chain reaction. In each of these studies high concentrations were used. We here report the study of the photolysis of a number of aromatic amines and alkyl halides in dilute solution. Tritolylamine (386 mg) and carbon tetrachloride (1 ml) in 50 ml of acetonitrile, for example, were photolyzed in a Pyrex flask. A Rayonet reactor with 16 21-watt mercury lamps with major output at 3100 Å was employed. Within a few minutes the solution was deep green from an absorption band which developed at 6750 Å; maximum absorption occurred after 1.5 hours. This absorption band is characteristic of the tritolylaminium ion