The spectral emittance of silicate dust is quite insensitive to temperature from 100 to 500 K. The results of Fig. 2 are consistent with a temperature of 250 K. Using this temperature it is possible to calculate the minimum angular diameter of a unit emissivity disk capable of radiating the observed 22 µm flux density. This value, 0·7 arc s, is near the resolving power of present telescopes; it seems more likely, however, that the 22 µm angular diameter is ten or twenty times the minimum value and should be readily measurable. It can be seen from Fig. 1 that the total infrared excess is about 0·5 per cent of the total flux emitted by the star, which implies very low optical depth near one micron and suggests a large diffuse cloud. Our 22 µm photometry, however, was carried out with various beam sizes from 37 arc s down to 5 arc s in diameter and no decrease with decreasing beam size was found. Thus even the present observations place moderately severe limits on the size of the circumstellar dust cloud; a direct observational test of the thermal reradiation model is now possible.

Assuming $T=250$ K, a mean particle radius of 0·2 µm and a distance of 180 pc, the total number of grains producing the observed flux density at 22 µm is calculated to be $\sim 1\times 10^{26}$ g.

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X-Ray Glow from Planetary Atmospheres

Unexpectedly high background X-radiation has been observed during a daytime stellar X-ray survey by rocket[1]. The source of the radiation is attributed to X-ray fluorescence of the Earth's atmosphere. The results of calculations of the X-ray fluorescence spectrum which could be observed from a spacecraft near a planet are presented here. This spectrum should be a valuable tool in the determination of the composition of planetary atmospheres, particularly with regard to the minor constituents such as neon and argon on Venus and Mars and nitrogen and carbon on Jupiter. It could also be used to detect and identify the atmosphere of Mercury.

Table 1 lists the characteristic K_α emissions of elements which make up planetary atmospheres, together with the probability of K fluorescence ω_K (ref. 2). The number of photons cm^{-2} s^{-1}, I, which would arrive at a point distance Z above the surface of a planet is given by

$$I=\int_V \int_{\lambda_0}^{\lambda_K} \frac{n_K(Z)\sigma_K(\lambda)\,\omega_K}{4\pi R_S{}^2}\, Q_\infty(\lambda)\, l^{-\tau_1(\lambda,Z,\chi)}\, l^{-\tau_2(\lambda_K,Z,\theta)}\, \mathrm{d}\lambda\, \mathrm{d}v$$

where $n_K(Z)$ is the number density of emitting atoms, $\sigma_K(\lambda)$ is the ionization cross-section, ω_K is the probability of fluorescence, $Q_\infty(\lambda)$ is the incident solar X-ray spectrum, $\tau_1(\lambda,Z,)\chi$ is the optical depth of the entering solar radiation and $\tau_2(\lambda_K, Z, \theta)$ the optical depth of the emitted radiation, and R_S is the distance between the emitting altitude and the observation point. The integration is performed over wavelength λ and emitting volume V encompassed by the total permissible solid angle.

Table 1. X-RAY FLUORESCENCE FROM PLANETARY ATMOSPHERES

Element	K_α (Å)	ω_K
C	44·54	0·0009
N	31·56	0·0015
O	23·57	0·0022
Ne	14·59	0·0081
Ar	4·19	0·12
Kr	0·98	0·66
Xe	0·42	0·88

Table 2 lists the results of the calculation at 4,000 km for different elements where the subsatellite point is the same as the subsolar point.

Table 2. EMISSION AT 4,000 KM (PHOTONS cm^{-2} s^{-1})

Element	Mercury	Venus	Earth	Mars	Jupiter
C		$3·4\times10^3$	$8·7\times10^{-1}$	$3·6\times10^2$	$4·6\times10^{-1}$
N		$3·2\times10$	$8·4\times10^3$		9·8
O		$2·2\times10^4$	$2·7\times10^3$	$2·4\times10^3$	
Ne	$3·7\times10^3$	$8·3\times10^2$		$1·1\times10^3$	
Ar	$2·8\times10$	$6·9\times10$	$6·4\times10$		

The results are limited by the great uncertainties in the atmospheric models. In the case of Mercury, two atmospheres were chosen, the first of neon with a surface pressure of 10^{-6} mb air and a constant scale height of 33 km, and the second of argon with the same scale height. For Venus three cases were considered in which 1 per cent argon, neon and nitrogen were added to the adopted model[3]. For Mars, the atmospheric model derived from the Mariner 6 and 7 radio occultation experiment was used[4]. In addition to CO_2 this model has as its principal constituent 10 per cent neon. Jupiter was considered although the chief constituents of its atmosphere are thought to be H_2 and He which do not show X-ray fluorescence. The adopted model[5] has CH_4 as 5×10^{-3} and NH_3 as 10^{-3} of the He concentration. Any increases in these proportions would lead to larger C and N photon fluxes in direct proportion. The same holds true for the constituents of other planets. Because the solar spectrum chosen was representative of a quiet Sun, periods of solar activity will increase the fluorescence emission particularly below 30 Å. It should be noted that precipitation of energetic particles will contribute to the fluorescence as discussed by Tomlin[6] for the Earth's auroral zone. Attempts to detect H_α emission from Jupiter have so far yielded negative results, however.

The flux behaves as $1/R_S{}^2$ and in most cases the constituents could be detected by instrumented spacecraft within 10^4 km of the planet. The flux expected at Earth orbit will on the average be 10^{-8} of that which appears at 4×10^3 km from the planet. This extremely small flux is probably less than the X-ray background, but if sophisticated instrumentation is available attempts should be made to detect a planetary X-ray flux.

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