Chapter 4

Infrared astronomy

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Infrared sources

The brightest members of the seven presently known classes of infrared sources (Jy = Jansky = fu = 10^{-26} W m^{-2} Hz^{-1}).

1. STARS			
α 1950	δ 1950	20μ flux den. (Jy)	Name
1^h04^m	12° 19′	0.83×10^3	CIT 3
2 17	−3 12	1.9	ö Cet
3 51	11 14	1.3	NML Tau
4 57	56 07	1.0	TY Cam
5 52	7 25	2.1	α Ori
7 21	−25 41	11	VY C Ma
9 45	11 39	1.1	R Leo
9 45	13 30	~25	IRC +10216
10 13	30 49	0.83	RW LMi
10 43	−59 25	~50	η Car
12 01	−32 04	2.7	IRC −30187
13 46	−28 07	1.9	W Hya
16 26	−26 19	1.0	α Sco
18 05	−22 16	2.1	VY Sgr
18 36	−6 51	2.5	EW Sct
18 45	−2 03	2.5	AB Agl
19 24	11 16	3.3	IRC +10420
20 08	−6 25	1.4	IRC −10529
20 20	37 22	1.1	BC Cyg
20 45	39 56	4.8	NML Cyg
21 42	58 33	0.69	μ Cep

2. PLANETARY NEBULA			
α 1950	δ 1950	20μ flux den. (Jy)	Name
21^h00^m	36° 30′	2.5×10^3	'Egg Nebula'
21 05	42 02	0.6	NGC 7027

3. H II REGIONS			
α 1950	δ 1950	20μ flux den. (Jy)	Name
2^h22^m	61° 52′	5.6×10^3	W3
5 33	−5 27	5.9	M42
5 39	−1 57	3.3	NGC 2024
17 44	−28 33	0.7	Sgr B2
18 01	−24 21	3.3	M8
18 06	−20 19	3.0	W31
18 11	−17 58	1.4	HFE50
18 16	−13 46	1.4	M16
18 18	−16 13	20	M17
18 43	−2 42	1.1	HFE 56
18 59	1 08	1.0	W48
19 08	9 02	1.7	HFE 58
19 11	10 48	1.2	?
19 20	13 59	1.2	HFE 59

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Infrared sources (*cont.*)

3. H II REGIONS			
α 1950	δ 1950	20μ flux den. (Jy)	Name
19^h21^m	14°24′	1.7×10^3	HFE 60
20 00	33 25	1.4	NGC 6857
20 26	37 13	1.2	Sharp 106
23 12	61 12	3.6	NGC 7358

4. MOLECULAR CLOUDS			
α 1950	δ 1950	100μ flux den. (Jy)	Name
2^h22^m	61°52′	$\sim 10^4$	W3 IRS 5
5 33	−5 27	1×10^5	KL Neb
6 05	−6 23	5×10^4	Mon R2
16 23	−24 17	3×10^4	ρ Oph DK.Cl.
20 37	42 12	$\sim 10^4$	W75 S OH

5. GALACTIC NUCLEUS			
α 1950	δ 1950	20μ flux den. (Jy)	Name
17^h43^m	−28°54′	2.6×10^3	Sgr A

6. GALACTIC NUCLEI			
α 1950	δ 1950	20μ flux den. (Jy)	Name
00^h45^m	−25°34′	30	NGC 253
2 40	00 20	60	NGC 1068
9 52	69 55	100	M 82
12 55	56 15	6	MK 231

7. QSO			
α 1950	δ 1950	10μ flux den. (Jy)	Name
08^h53^m	20°15′	$0.04 \rightarrow 0.07$	OJ 287
12 27	2 20	$0.2 \rightarrow 0.5$	3C 273
22 01	42 12	$0.2 \rightarrow 0.7$	BL Lac

(Adapted from Low, F. in *Symposium on Infrared and Submillimeter Astronomy*, G. G. Fazio, ed., D. Reidel Publishing Company, 1977.)

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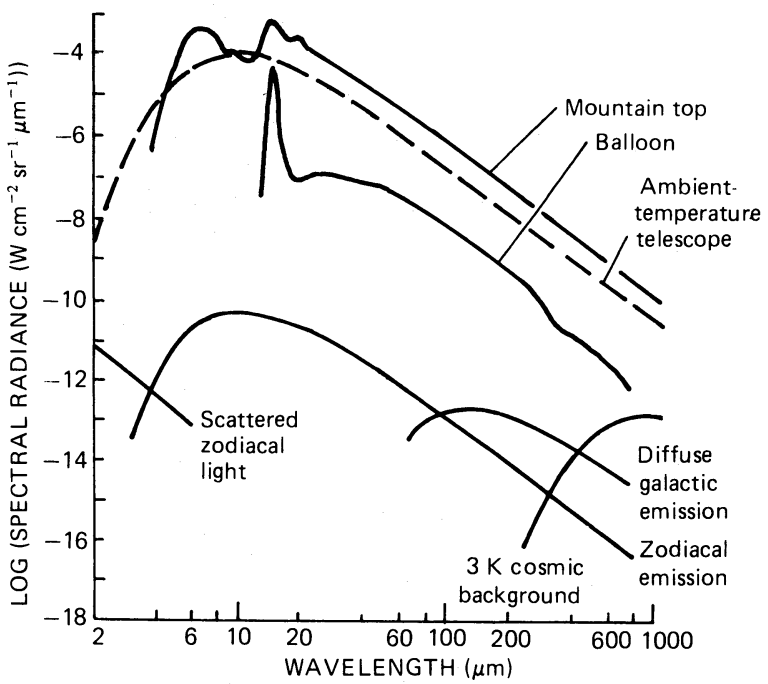
Infrared background fluxes. (Adapted from Rieke, G. H. *et al.*, *Science*, **231**, 807, 1986.)



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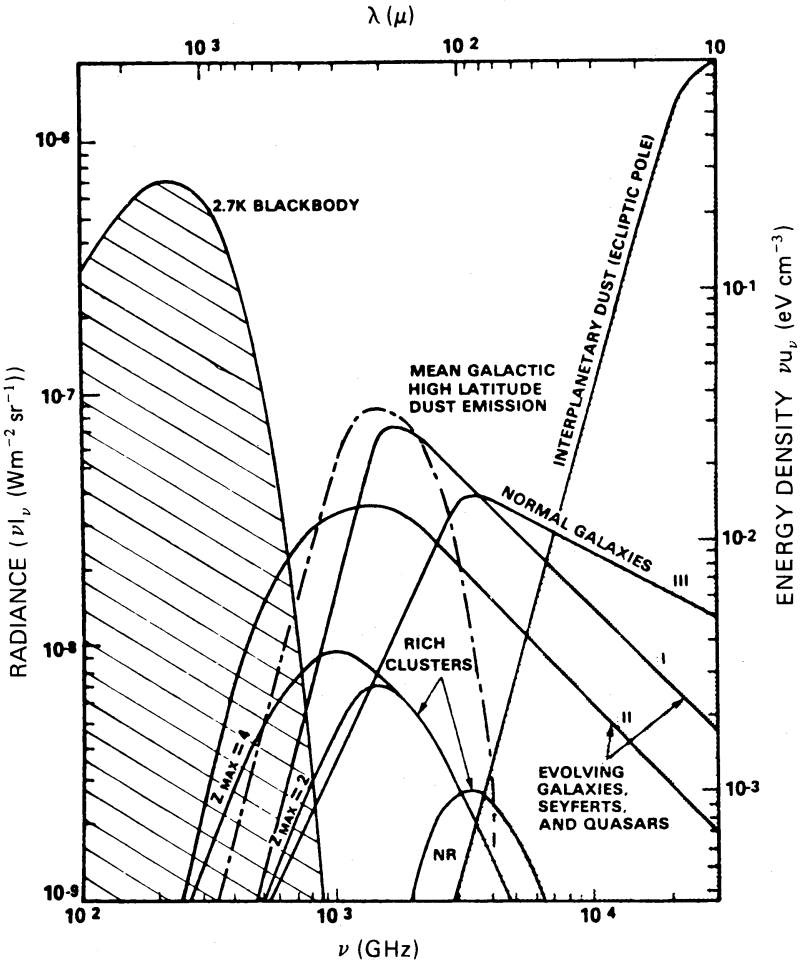
Infrared background (*cont.*)

Predicted diffuse far-infrared radiation fluxes. The curve marked NR is an estimate of the contribution from rich clusters neglecting redshift and other relativistic effects. (Adapted from Stecker, F. W., Puget, J. L. & Fazio, G. G., *Ap. J.* (*Lett.*), **214**, L51, 1977.)



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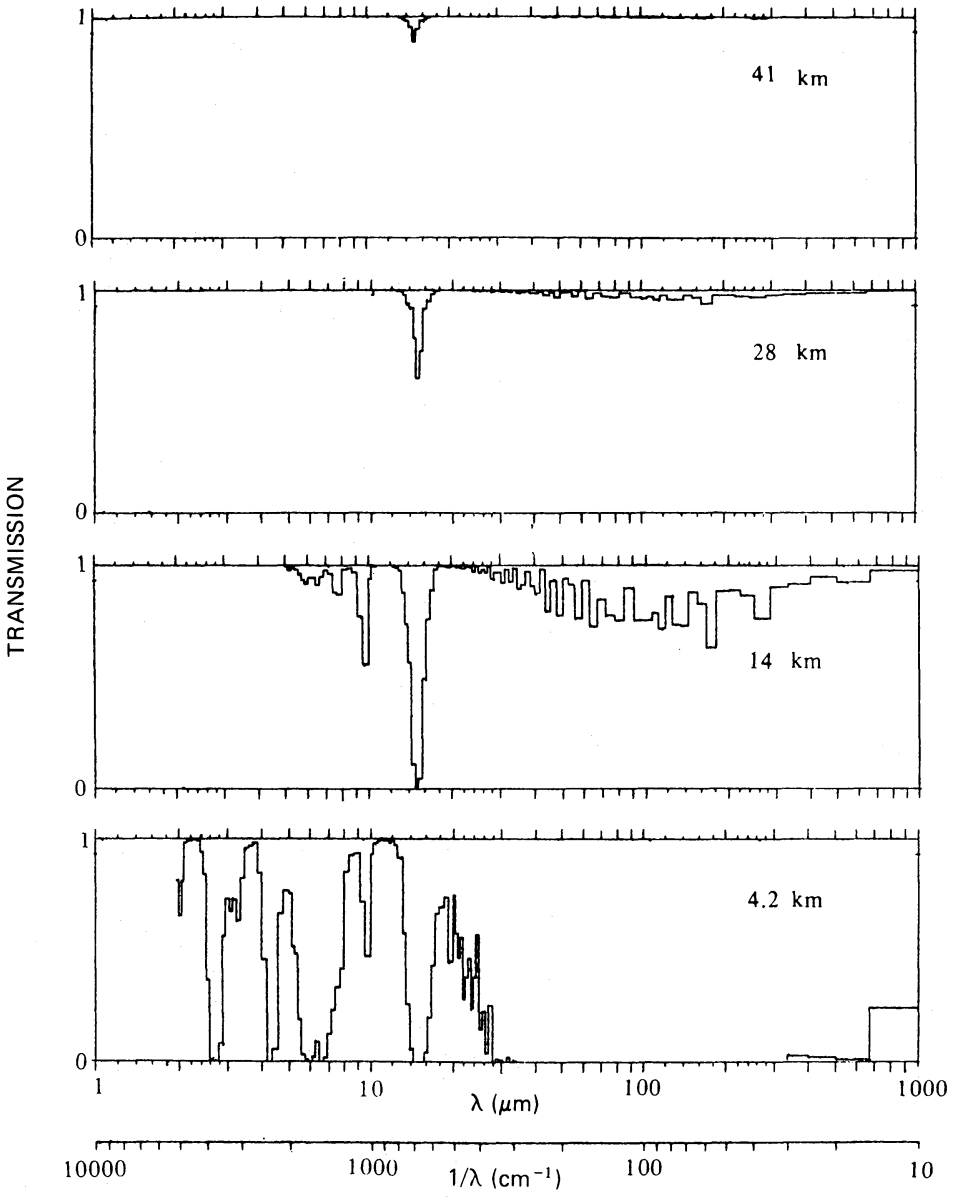
Atmospheric transmission

Transmission of the atmosphere at infrared wavelengths at four altitudes. (Adapted from Fazio, G. G. in *Frontiers of Astrophysics*, E. H. Avrett, ed., Harvard University Press, Cambridge, 1976.)



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Source temperatures

Brightness temperature

$$T_b(\nu) = \frac{c^2 B_\nu}{2\nu^2 k} \quad \text{(Rayleigh–Jeans approximation)}.$$

T_b is the temperature of a blackbody which would have the same spectral radiance B_ν at frequency ν as the source.

Color temperature

$$\frac{B_{\lambda_1}}{B_{\lambda_2}} = \left(\frac{\lambda_2}{\lambda_1}\right)^5 \frac{e^{hc/\lambda_2 k T_c} - 1}{e^{hc/\lambda_1 k T_c} - 1}.$$

B_λ is the spectral radiance of source at wavelength λ.

Effective temperature

$$L = 4\pi R^2 \sigma T_{\text{eff}}^4,$$

where

L = source power,
R = radius of source,
σ = Stefan–Boltzmann constant.

Blackbody flux densities for stars

The blackbody spectral flux density for a star is given by,

$$F_\lambda = \frac{1.9 \times 10^{-11} \lambda^{-5} p^2 R^2}{e^{14\,388/\lambda T} - 1} \quad (\text{W cm}^{-2}\,\mu\text{m}^{-1})$$

where

R = radius of star (in units of the Sun's radius),
p = parallax (arcsec),
T = temperature (K),
λ = wavelength (μm).

(Johnson, H. M. & Wright, C. D., *Ap. J. Suppl.*, **53**, 643, 1983),

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