APPENDICES

Physical Constants

Light speed (in vacus)	$c=2.997925\times10^{10}$cm/sec $=2.997925\times10^{8}$m/sec	Planck's constant	$\frac{m_H}{m}=1836.12$ $h=6.62618\times10^{-27}$erg·sec $=6.62618\times10^{-34}$J·sec
Gravitational constant Avogadro's number (mole)	6.672×10^{-8}dyn·cm^2/g^2 $=6.672\times10^{-11}$N·m^2/kg^2 $N_0=6.022\times10^{23}$		$\hbar=\frac{h}{2\pi}=1.055\times10^{-27}$erg/sec $=1.055\times10^{-34}$J/sec
Loschmidt number, airmolecules in 1 cm^3 (0°C, 1 atm.)	$n=2.687\times10^{19}$/cm^3	Bohr radius	$a_0=\frac{\hbar^2}{me^2}=5.2918\times10^{-9}$cm $=5.2918\times10^{-11}$m
Air volume of 1 mole at 0°C, 1 atm.	22.41 l	Bohr magneton	$\mu_B=\frac{he}{4\pi mc}$ $=0.92741\times10^{-20}$erg/gauss $=0.92741\times10^{-27}$J/gauss
Gas constant	$R=8.314\times10^{7}$erg/K $=8.314$J/K $=1.986$cal/K	Magnetic moment of proton	1.41061×10^{-23}erg/gauss
Boltzmann constant	$k=\frac{R}{N_0}=1.381\times10^{-16}$erg/K $=1.381\times10^{-23}$J/K	Rydberg constant (Nucleus of infinite mass)	$R_\infty=1.09737\times10^{5}$/cm $=1.09737\times10^{7}$/m
Mechanical equivalent of heat	$J=4.186\times10^{7}$erg/K $=4.186$J/K	electron volt	$1\text{eV}=1.60219\times10^{-12}$erg $=1.60219\times10^{-19}$J
Absolute 0° K	0 °K$=-273.15$°C	Wavelength of a spectral line from ^{86}Kr	1 m$=1650763.73\lambda_{Kr}$
Faraday's constant	$eN_0=96484.6$C/ mol	Standard acceleration of gravity	$g_n=980.665$cm/sec^2 $=9.80665$m/sec^2
Electronic charge $-e$	$e=1.60219\times10^{-19}$C $=4.803242\times10^{-10}$esu	Standard pressure (760mmHg)	1.013250×10^{6}dyn/cm^2 $=1.013250\times10^{5}$N/m^2
Electronic mass	$m_e=9.1095\times10^{-10}$g $=9.1095\times10^{-31}$kg		
Hydrogen mass	$m_H=1.6733\times10^{-24}$g $=1.6733\times10^{-27}$kg		

Astronomical Constants

Astronomical Unit (AU)		1.496×10^{13}cm
Parsec (pc)		3.085×10^{18}cm$=206\ 265$AU$=3.26$ light years
Sidereal year		$365.256\text{day}=3.1558\times10^{7}$sec
Earth		
Equatorial radius		6.378×10^{8}cm
Mass		5.977×10^{27}g
Sun		
Radius $R_\odot$		6.96×10^{10}cm
Mass $M_\odot$		1.989×10^{33}g
Surface gravity $g_\odot$		2.736×10^{4}cm·sec^{-2}
Luminosity $L_\odot$	$4\pi R_\odot^2\cdot\pi F_\odot$	$=3.90\times10^{33}$erg·sec^{-1}
Effective temperature T_{eff}		5 780°K

A magnitude corresponds to the change of brightness by 2.5125 times.
Absolute magnitude is determined in referencce to the distance of 10 pc from the Sun.

Masses and the relative abundances of nuclei

atomic number		mass[1]	relative abundance (%)	cosmic abundances[2] number	cosmic abundances[2] mass	atomic number		mass[1]	relative abundance (%)	cosmic abundances[2] number	cosmic abundances[2] mass
1	^{1}H	1.0078252	99.985	12.00	12.00	22	^{46}Ti	45.952631	7.99	4.82	6.50
	^{2}H	2.0141022	0.015				^{47}Ti	46.951768	7.32		
2	^{3}He	3.0160296	1.3×10^{-4}	11.16	11.76		^{48}Ti	47.947951	73.99		
	^{4}He	4.0026032	100				^{49}Ti	48.947870	5.46		
3	^{6}Lj	6.015124	7.42	3	4		^{50}Ti	49.944786	5.25		
	^{7}Li	7.016004	92.58			23	^{50}V	49.947164	0.25	3.78	5.48
4	^{9}Be	9.012186	100	2.4	3.4		^{51}V	50.943961	99.75		
5	^{10}B	10.012939	19.6−19.8	2.8	3.8	24	^{50}Cr	49.946055	4.31	5.38	7.09
	^{11}B	11.0093053	80.2−80.4				^{52}Cr	51.940481	83.76		
6	^{12}C	12.0000000	98.892	8.48	9.56		^{53}Cr	52.940653	9.55		
	^{13}C	13.003355	1.108				^{54}Cr	53.938881	2.38		
7	^{14}N	14.0030744	99.635	7.96	9.11	25	^{55}Mn	54.938050	100	5.10	6.84
	^{15}N	15.000107	0.365			26	^{54}Fe	53.939617	5.84	6.90	8.65
8	^{16}O	15.9949150	99.759	8.83	10.03		^{56}Fe	55.934937	91.68		
	^{17}O	16.999133	0.037				^{57}Fe	56.935397	2.17		
	^{18}O	17.9991601	0.204				^{58}Fe	57.933281	0.31		
9	^{19}F	18.998415	100	5.4	6. 7	27	^{59}Co	58.933189	100	4.72	6.49
10	^{20}Ne	19.992440	90.92	8.44	9.74	28	^{58}Ni	57.93534	67.76	5.93	7.70
	^{21}Ne	20.993849	0.257				^{60}Ni	59.930787	26.16		
	^{22}Ne	21.9913847	8.82				^{61}Ni	60.93106	1.25		
11	^{23}Na	22.98977	100	6.22	7.58		^{62}Ni	61.92834	3.66		

12	^{24}Mg	23.985042	78.60	7.46	8.84
	^{25}Mg	24.985839	10.11		
	^{26}Mg	25.982593	11.29		
13	^{27}Al	26.981539	100	6.28	7.71
14	^{28}Si	27.976929	92.18	7.47	8.92
	^{29}Si	28.976495	4.71		
	^{30}Si	29.973763	3.12		
15	^{31}P	30.973764	100	5.53	7.02
16	^{32}S	31.972073	95.0	7.22	8.72
	^{33}S	32.971462	0.76		
	^{34}S	33.967864	4.22		
	^{36}S	35.96708	0.014		
17	^{35}Cl	34.968851	75.53	5.4	6.9
	^{37}Cl	36.965898	24.47		
18	^{36}Ar	35.967544	0.337	6.62	8.22
	^{38}Ar	37.962728	0.063		
	^{40}Ar	39.962385	99.600		
19	^{39}K	38.963710	93.22	4.88	6.47
	^{40}K	39.964000	0.0118		
	^{41}K	40.961833	6.77		
20	^{40}Ca	39.962589	96.97	6.22	7.82
	^{42}Ca	41.958625	0.64		
	^{43}Ca	42.958780	0.145		
	^{44}Ca	43.955490	2.06		
	^{46}Ca	45.95370	0.0033		
	^{48}Ca	47.95253	0.185		
21	^{45}Sc	44.955919	100	2.91	4.56
	^{64}Ni	63.92795	1.16		
29	^{63}Cu	62.929593	69.1	4.65	6.45
	^{65}Cu	64.92778	30.9		
30	^{64}Zn	63.92915	48.89	4.28	6.09
	^{66}Zn	65.92605	27.81		
	^{67}Zn	66.92715	4.11		
	^{68}Zn	67.92486	18.56		
	^{70}Zn	69.92533	0.62		
31	^{69}Ga	68.925574	60.2	2.45	4.29
	^{71}Ga	70.924706	39.8		
32	^{70}Ge	69.924252	20.55	3.18	5.04
	^{72}Ge	71.922082	27.37		
	^{73}Ge	72.923463	7.67		
	^{74}Ge	73.921180	36.74		
	^{76}Ge	75.921406	7.67		
33	^{75}As	74.921597	100	2.3	4.2
34	^{74}Se	73.922476	0.87	3.2	5.1
	^{76}Se	75.91920	9.02		
	^{77}Se	76.91991	7.58		
	^{78}Se	77.917313	23.52		
	^{80}Se	79.916528	49.82		
	^{82}Se	81.91670	9.19		
35	^{79}Br	78.918329	50.52	2.6	4.5
	^{81}Br	80.91629	49.48		
36	^{78}Kr	77.92041	0.354	3.2	5.1
	^{80}Kr	79.91638	2.27		
	^{82}Kr	81.913483	11.56		

atomic number		mass[1]	relative abundance (%)	cosmic abundances[2] number	cosmic abundances[2] mass
	^{83}Kr	82.914131	11.55		
	^{84}Kr	83.911503	56.90		
	^{86}Kr	85.910616	17.37		
37	^{85}Rb	84.91180	72.15	2.35	4.28
	^{87}Rb	86.909186	27.85		
38	^{84}Sr	83.913430	0.56	2.75	4.69
	^{86}Sr	85.909285	9.86		
	^{87}Sr	86.908892	7.02		
	^{88}Sr	87.90564	82.56		
39	^{89}Y	88.905872	100	2.40	4.34
40	^{90}Zr	89.904700	51.46	2.4	4.4
	^{91}Zr	90.905642	11.23		
	^{92}Zr	91.905031	17.11		
	^{94}Zr	93.906314	17.40		
	^{96}Zr	95.908286	2.80		
41	^{93}Nb	92.906381	100	1.7	3.7
42	^{92}Mo	91.906811	15.86	1.92	3.90
	^{94}Mo	93.905090	9.12		
	^{95}Mo	94.905839	15.70		
	^{96}Mo	95.904674	16.50		
	^{97}Mo	96.906022	9.45		
	^{98}Mo	97.905409	23.75		
	^{100}Mo	99.907475	9.62		
	^{114}Sn	113.902768	0.65		
	^{115}Sn	114.90335	0.34		
	^{116}Sn	115.901746	14.24		
	^{117}Sn	116.902959	7.57		
	^{118}Sn	117.901606	24.01		
	^{119}Sn	118.903313	8.58		
	^{120}Sn	119.902199	32.97		
	^{122}Sn	121.903441	4.71		
	^{124}Sn	123.905272	5.98		
51	^{121}Sb	120.903817	57.25	1.6	3.7
	^{123}Sb	122.904213	42.75		
52	^{120}Te	119.90402	0.089	2.0	4.1
	^{122}Te	121.90307	2.46		
	^{123}Te	122.90428	0.87		
	^{124}Te	123.90284	4.61		
	^{125}Te	124.90442	6.99		
	^{126}Te	125.90333	18.71		
	^{128}Te	127.90447	31.79		
	^{130}Te	129.90624	34.49		
53	^{127}I	126.904470	100	1.4	3.5
54	^{124}Xe	123.9061	0.096	2.0	4.1
	^{126}Xe	125.90429	0.090		
	^{128}Xe	127.90354	1.919		

44	^{96}Ru	95.90760	5.46	1.52	3.52
	^{98}Ru	97.905288	1.868		
	^{99}Ru	98.905936	12.63		
	^{100}Ru	99.904218	12.53		
	^{101}Ru	100.905577	17.02		
	^{102}Ru	101.904348	31.6		
	^{104}Ru	103.905430	18.87		
45	^{103}Rh	102.905512	100	0.78	2.79
46	^{102}Pd	101.90561	0.96	1.25	3.28
	^{104}Pd	103.90401	10.97		
	^{105}Pd	104.90507	22.2		
	^{106}Pd	105.90348	27.3		
	^{108}Pd	107.90389	26.7		
	^{110}Pd	109.90516	11.8		
47	^{107}Ag	106.905094	51.35	0.7	2.7
	^{109}Ag	108.904757	48.65		
48	^{106}Cd	105.906463	1.22	1.50	3.55
	^{108}Cd	107.904187	0.88		
	^{110}Cd	109.903012	12.39		
	^{111}Cd	110.904189	12.75		
	^{112}Cd	111.902762	24.07		
	^{113}Cd	112.904409	12.26		
	^{114}Cd	113.903360	28.86		
	^{116}Cd	115.904762	7.58		
49	^{113}In	112.90409	4.23	0.9	3.0
	^{115}In	114.90387	95.77		
50	^{112}Sn	111.90484	0.95	1.55	3.62
	(^{129}Xe)	128.904784	26.44		
	^{130}Xe	129.90351	4.08		
	^{131}Xe	130.905085	21.18		
	^{132}Xe	131.904161	26.89		
	^{134}Xe	133.905397	10.4		
	^{136}Xe	135.90722	8.87		
55	^{133}Cs	132.90535	100	1.1	3.2
56	^{130}Ba	129.90625	0.101	2.11	4.25
	^{132}Ba	131.9051	0.097		
	^{134}Ba	133.90461	2.42		
	^{135}Ba	134.9055	6.59		
	^{136}Ba	135.9043	7.81		
	^{137}Ba	136.9055	11.32		
	^{138}Ba	137.9050	71.66		
57	^{138}La	137.9069	0.089	1.4	3.5
	^{139}La	138.90614	99.911		
58	^{136}Ce	135.9070	0.193	1.6	3.7
	^{138}Ce	137.9058	0.250		
	^{140}Ce	139.90539	88.48		
	^{142}Ce	141.90914	11.07		
59	^{141}Pr	140.90760	100	0.8	3.0
60	^{142}Nd	141.90766	27.13	1.5	3.7
	^{143}Nd	142.90978	12.20		
	^{144}Nd	143.91004	23.87		
	^{145}Nd	144.91254	8.29		
	^{146}Nd	145.91308	17.18		
	^{148}Nd	147.91686	5.72		

atomic number		mass[1]	relative abundance (%)	cosmic abundances[2] number	cosmic abundances[2] mass
	^{150}Nd	149.92091	5.60		
62	^{144}Sm	143.91199	3.16	1.0	3.2
	^{147}Sm	146.91487	15.07		
	^{148}Sm	147.91479	11.27		
	^{149}Sm	148.91718	13.82		
	^{150}Sm	149.91727	7.47		
	^{152}Sm	151.91975	26.63		
	^{154}Sm	153.92228	22.53		
63	^{151}Eu	150.91984	47.77	0.7	2.9
	^{153}Eu	152.92124	52.23		
64	^{152}Gd	151.91979	0.20	1.1	3. 3
	^{154}Gd	153.92093	2.15		
	^{155}Gd	154.92266	14.7		
	^{156}Gd	155.92218	20.47		
	^{157}Gd	156.92402	15.68		
	^{158}Gd	157.92417	24.9		
	^{160}Gd	159.92712	21.9		
65	^{158}Tb	158.92536	100.	0.4	2.6
66	^{156}Dy	155.9239	0.0524	1.2	3.4
	^{158}Dy	157.92445	0.0902		
	^{160}Dy	159.92521	2.294		
	^{161}Dy	160.92694	18.88		
	^{162}Dy	161.92680	25.53		
	^{163}Dy	162.92876	24.97		
	^{164}Dy	163.92920	28.18		
	^{179}Hf	178.9460	13.75		
	^{180}Hf	179.9469	35.22		
73	^{180}Ta	179.94755	0.0123	0.3	2.6
	^{181}Ta	180.94801	99.9877		
74	^{180}W	179.94700	0.135	1.1	3.4
	^{182}W	181.94830	26.4		
	^{183}W	182.95033	14.4		
	^{184}W	183.95102	30.6		
	^{186}W	185.95444	28.4		
75	^{185}Re	184.95305	37.07	0.6	2.9
	^{187}Re	186.95583	62.93		
76	^{184}Os	183.9528	0.018	1.3	3.6
	^{186}Os	185.9538	1.59		
	^{187}Os	186.95583	1.64		
	^{188}Os	187.95608	13.3		
	^{189}Os	188.9583	16.1		
	^{190}Os	189.9587	26.4		
	^{192}Os	191.9615	41.0		
77	^{191}Ir	190.9606	38.5	1.2	3.5
	^{193}Ir	192.96302	61.5		
78	^{190}Pt	189.9600	0.0127	1.2	3.9
	^{192}Pt	191.9611	0.78	1.6	3.9
	^{194}Pt	193.96273	32.9		
	^{195}Pt	194.96481	33.8		
	^{196}Pt	195.96497	25.2		

67	^{165}Ho	164.93042	100	0.5	2.7
68	^{162}Er	161.9287	0.136	0.9	3.2
	^{164}Er	163.92928	1.56		
	^{166}Er	165.93030	33.41		
	^{167}Er	166.93205	22.94		
	^{168}Er	167.93239	27.07		
	^{170}Er	169.9356	14.18		
69	^{169}Tm	168.93424	100	0.1	2.3
70	^{168}Yb	167.9342	0.140	1.1	3.3
	^{170}Yb	169.9350	3.03		
	^{171}Yb	170.9364	14.31		
	^{172}Yb	171.9363	21.82		
	^{173}Yb	172.9381	16.13		
	^{174}Yb	173.9387	31.84		
	^{176}Yb	175.9427	12.73		
71	^{175}Lu	174.9406	97.40	0.3	2.5
	^{176}Lu	175.9427	2.60		
72	^{174}Hf	173.9403	0.163	0.6	2.8
	^{176}Hf	175.9416	5.21		
	^{177}Hf	176.9434	18.56		
	^{178}Hf	177.9439	27.1		
	^{198}Pt	197.96789	7.19		
79	^{197}Au	196.96654	100	0.7	3.0
80	^{196}Hg	195.96582	0.146	0.9	3.2
	^{198}Hg	197.96675	10.02		
	^{199}Hg	198.96828	16.84		
	^{200}Hg	199.96833	23.13		
	^{201}Hg	200.97031	13.22		
	^{202}Hg	201.97064	29.80		
	^{204}Hg	203.97349	6.85		
81	^{203}Tl	202.97236	29.50	0.5	2.8
	^{205}Tl	204.97444	70.50		
82	^{204}Pb	203.97304	1.40	1.6	3.9
	^{206}Pb	205.97446	25.2		
	^{207}Pb	206.97590	21.7		
	^{208}Pb	207.97665	51.7		
83	^{209}Bi	208.98040	100	0.7	3.0
90	^{232}Th	232.03808	100	0.3	2.7
92	^{234}U	234.04097	0.0057	0.0	2.4
	^{235}U	235.04394	0.7196		
	^{238}U	238.05081	99.276		

1) Normalyzed by ^{12}C=12.0000000.

2) Logarithmic values numerated for each element from the data on the sun, stars, nebulae and the earth's crust. Normalized as H=12.00.

Properties of particles

			Symbol particle	Symbol composition	Symbol anti-particle	Spin ($\hbar$)	Magnetic moment (unit: $e\hbar/2m_p c$ for heavy particle)	Mass (MeV)	Mean life (sec)
Photon			γ		γ	1	0	0	stable
Lepton	neutrino		ν_e, ν_μ, ν_τ		$\bar{\nu}_e$, $\bar{\nu}_\mu$, $\bar{\nu}_\tau$	1/2	(0)	~ 0	stable
	electron		e^-		e^+	1/2	$1.0011596524 \times e\hbar/2m_e c$	0.5110034	stable
	μ particle		μ^-		μ^+	1/2	$1.001165922 \times e\hbar/2m_\mu c$	105.6595	2.1971×10^{-6}
	τ particle		τ^-		τ^+	1/2		1782	$<10^{-11}$
Meson	π meson		π^0	$u\bar{u}-d\bar{d}$	π^0	0	0	134.9626	0.83×10^{-16}
			π^+	$u\bar{d}$	π^-	0	0	139.5669	2.6030×10^{-8}
	K meson		K^+	$u\bar{s}$	K^-	0	0	493.668	1.2371×10^{-8}
			K^0	$d\bar{s}$	$\bar{K}^0$	0	0	497.67	K_S^0 : 0.892×10^{-10} K_L^0 : 5.183×10^{-8}
Heavy particle	Nucleon N	proton	p	uud	$\bar{p}$	1/2	2.7928456 ± 0.0000011	938.2796	stable
		neutron	n	udd	$\bar{n}$	1/2	-1.913042 ± 0.000001	939.5731	0.918×10^3
	Heavy nucleon Y	Λ particle	Λ	uds	$\bar{\Lambda}$	1/2	-0.606 ± 0.03	1115.60	2.632×10^{-10}
		Σ particle	Σ^+	uus	$\bar{\Sigma}^+$	1/2	2.33 ± 0.13	1189.37	0.802×10^{-10}
			Σ^0	uds	$\bar{\Sigma}^0$	1/2		1192.47	5.8×10^{-20}
			Σ^-	dds	$\bar{\Sigma}^-$	1/2	-1.48 ± 0.37	1197.35	1.483×10^{-10}
		Ξ particle	Ξ^0	uss	$\bar{\Xi}^0$	1/2	-1.24 ± 0.01	1314.9	2.90×10^{-10}
			Ξ^-	dss	$\bar{\Xi}^-$	1/2	-1.85 ± 0.75	1321.32	1.654×10^{-10}
	Ω particle		Ω^-	sss	$\bar{\Omega}^-$	3/2		1672.2	1.1×10^{-10}

Decay patterns of unstable particles

Particles	Decay mode	Q Value (MeV)	Splitting ratio (%)
μ^-	$\rightarrow e^- + \nu_\mu + \bar{\nu}_e$	105.15	100
π^+	$\rightarrow \mu^+ + \nu_\mu$	33.94	99.99
	$\rightarrow e^+ + \nu_e$	139.09	$(1.27 \pm 0.03) \times 10^{-4}$
π^0	$\rightarrow 2\gamma$	134.96	99
K^+ $K^+_{\mu 2}$	$\rightarrow \mu^+ + \nu_\mu$	388.1	63.5 ± 0.2
$K^+_{\pi 2}, \theta^+$	$\rightarrow \pi^+ + \pi^0$	219.2	21.1 ± 0.2
τ^+	$\rightarrow 2\pi^+ + \pi^-$	75.0	5.6 ± 0.03
$\tau^{+\prime}$	$\rightarrow \pi^+ + 2\pi^0$	84.2	1.7 ± 0.5
K^+_{e3}	$\rightarrow e^+ + \nu_e + \pi^0$	358.3	4.8 ± 0.1
$K^+_{\mu 3}$	$\rightarrow \mu^+ + \nu_\mu + \pi^0$	253.1	3.2 ± 0.1
K^0_S	$\rightarrow \pi^+ + \pi^-$	218.8	68.7 ± 0.3
	$\rightarrow 2\pi^0$	228.0	31.3 ± 0.3
	$\rightarrow e^\pm + \{\nu_e, \bar{\nu}_e\} + \pi^\mp$	357.9	~ 0.1
	$\rightarrow \mu^\pm + \{\nu_\mu, \bar{\nu}_\mu\} + \pi^\mp$	252.7	
K^0_L	$\rightarrow e^\pm + \{\nu_e, \bar{\nu}_e\} + \pi^\mp$	357.9	39.0 ± 0.6
	$\rightarrow \mu^\pm + \{\nu_\mu, \bar{\nu}_\mu\} + \pi^\mp$	252.7	27.1 ± 0.6
	$\rightarrow \pi^+ + \pi^- + \pi^0$	83.8	12.3 ± 0.3
	$\rightarrow 3\pi^0$	93.0	21.4 ± 0.8
n	$\rightarrow p + e^- + \bar{\nu}_e$	0.78	100
Λ	$\rightarrow p + \pi^-$	37.56	64.2 ± 0.5
	$\rightarrow n + \pi^0$	40.85	35.8 ± 0.5
	$\rightarrow p + e^- + \bar{\nu}_e$	176.64	~ 0.1
Σ^+	$\rightarrow p + \pi^0$	116.1	51.6 ± 0.7
	$\rightarrow n + \pi^+$	110.3	48.4 ± 0.7
	$\rightarrow p + \gamma$	251.1	~ 0.1
Σ^0	$\rightarrow \Lambda + \gamma$	76.9	100
Σ^-	$\rightarrow n + \pi^-$	118.2	100
Ξ^-	$\rightarrow \Lambda + \pi^-$	66.1	~ 100
Ξ^0	$\rightarrow \Lambda + \pi^0$	64.3	~ 100

K^+ is occasionally expressed as $K^+_{\mu 2}$ or θ^+ in accordance with the decay modes.

Resonant states of hadrons

Symbol	composition	Charge (e)	Spin ($\hbar$)	Mass (MeV)	Equivalent width (MeV)
η	$k\bar{k}$, $s\bar{s}$	0	0	549	0.001
η'		0	0	958	<1
D	$c\bar{k}$, $k\bar{c}$	$\pm1, 0, 0$	0	1866	~ 0[1]
F	$c\bar{s}$, $s\bar{c}$	±1	0	2030	~ 0[1]
ρ	$k\bar{k}$	$\pm1, 0$	1	776	155
ω	$u\bar{u}+d\bar{d}$	0	1	783	10
K*	$s\bar{k}$, $k\bar{s}$	$\pm1, 0, 0$	1	892	50
ϕ	$s\bar{s}$	0	1	1020	4
D*	$c\bar{k}$, $k\bar{c}$	$\pm1, 0, 0$	1	2007	<2
F*	$c\bar{s}$, $s\bar{c}$	±1	1	2140	?
J/ψ	$c\bar{c}$	0	1	3097	0.07
ψ'	$c\bar{c}$	0	1	3686	0.23
ψ''	$c\bar{c}$	0	1	3772	28
Υ	$b\bar{b}$	0	1	9450	0.04
Υ'	$b\bar{b}$	0	1	10010	<0.01
f	$u\bar{u}+d\bar{d}$	0	2	1271	180
A_2	$k\bar{k}$	$\pm1, 0$	2	1312	102
K_2	$s\bar{k}$, $k\bar{s}$	$\pm1, 0, 0$	2	1434	100
f'	$s\bar{s}$	0	2	1516	65
χ_2	$c\bar{c}$	0	2	3554	?
χ_1	$c\bar{c}$	0	1	3508	?
χ_0	$c\bar{c}$	0	0	3413	?
Δ[2]	kkk	$2, 1, 0, -1$	3/2	1232	115
Σ^*	kks	$1, 0, -1$	3/2	1384	38
Ξ^*	kss	$0, -1$	3/2	1533	10

1) Given here for our convenience.
2) Other anti-particles exist in addition to those for spin 3/2.

Supernova remnants (SNR)

Name	1950.0 right ascension	1950.0 declination	gal. long.	gal. lat.	radio intensity (1 GHz) S	spectral index a[1)]	seeing diameter	diameter	expanding speed	distance	remark
	h m	° ′	°	°	Jy			l.y.	km·sec^{-1}	$\times 10^4$ l.y.	
Kepler	17 27.7	−21 27	5	−7	20	0.58	3.0	16−30	200−300	1.9−3.3	1604 explosion
W 44	18 53.7	+01 11	35	−1	190	0.40	31	90		1.0	
W 49 B	19 08.7	+09 01	43	−0	39	0.33	4.8	45		3.3	
Cygnus Loop	22 47.6	+30 18	74	−9	160	0.45	180	140		0.3	Loop nebula, NGC 6992/95
Cas A	23 21.2	+58 33	112	−2	3100	0.77	4.3	12	7400	1.0	
Tycho	00 22.6	+63 52	120	+1	52	0.74	8.1	40	4700	1.6	1572 explosion
Tau A	05 31.5	+21 59	185	−6	1000	0.25	3.6	7	1500	0.7	Crab nebula M1, 1054 explosion
IC 443	06 13.8	+22 29	189	+3	180	0.45	40	40−80		0.3−0.7	
Vela XYZ	08 32.2	−45 01	263	−3	1800	0.30	200	95		0.16	

1) spectral index when expressed as $S \propto \nu^{3-a}$

Catalogue for 98 supernova remnants

Supernova position	Name	Luminosity at 408 MHz (Jy)	Luminosity at 5000 MHz (Jy)	Spectral index $\left(\alpha \begin{smallmatrix}5000\\408\end{smallmatrix}\right)$	Angular diameter (min.)	Surface brightness Σ_{408} ($W \cdot m^{-2} \cdot Hz^{-1} \cdot sr^{-1}$)
G193.3−1.5	PKS 0607+17	42			80	0.984 E-21
G205.5+0.2	Monoceros	180		(−0.5)	253	0.412 E-21
G206.9+2.3	PKS 0646+06	8			80	0.187 E-21
G260.4−3.4	Puppis A	198	59	−0.48	47	0.134 E-19
G261.9+5.5	PKS 0902−38	12			40	0.112 E-20
G263.9−3.3	Vela X, Y, Z	2300		(−0.5)	256	0.526 E-20
G287.8−0.5					<42	
G290.1−0.8	MSH 11−61 A	112	28	−0.55	12.6	0.106 E-18
G291.0−0.1	MSH 11−62	22	9.2	−0.35	10.0	0.330 E-19
G292.0+1.8	MSH 11−54	21	7.6	−0.41	5.4	0.108 E-18
G293.8+0.6		9.0	2.1	−0.58	9. 0	0.730 E-20
G296.1−0.7		6.9		−0.7	16.0	0.404 E-20
G296.5+10.0	PKS 1209−51	85	30	−0.45	81	0.194 E-20
G296.8−0.3		15.0	3.2	−0.62	14.9	0.101 E-19
G298.5−0.3		(7.4)		−0.36	3.7	0.793 E-19
G298.6+0.0		(5.6)		−0.30	8.3	0.121 E-19
G299.0+0.2		12.6	4.7	−0.39	10.5	0.171 E-19
G302.3+0.7		7.5	3.0	−0.36	16.5	0.143 E-20
G304.6+0.1	Kes 17	22	6.7	−0.48	6.9	0.693 E-19
G308.7+0.0		16.7	7.0	−0.35	7.3	0.470 E-19
G309.2−0.6		10	3.9	−0.37	12.6	0.945 E-20
G309.8+0.0		26.4	7.4	−0.51	19.2	0.107 E-19
G311.5−0.3		(5.7)	(1.7)	−0.48	3.9	0.548 E-19
G315.4−0.3		15.9	4.9	−0.47	16.0	0.935 E-20
G315.4−2.3	RCW 86	86	18.2	−0.62	39	0.848 E-20
G316.3−0.0	MSH 14−57	37	16.7	−0.32	17.1	0.189 E-19
G320.4−1.2	RCW 89, MSH 15−52	94	40	−0.34	25.8	0.212 E-19
G321.9−0.3		18.3	7.8	−0.34	24.2	0.469 E-20
G322.3−1.2	Kes 24	12.4	1.3	−0.90	5.8	0.553 E-19
G323.5+0.1		4.2	1.5	−0.41	10.8	0.540 E-20
G326.3−1.8	MSH 15−56	180	98	−0.24	36	0.208 E-19
G327.1−1.1		10.6	4.3	−0.36	14.2	0.788 E-20
G327.4+0.4	Kes 27	58	12.4	−0.61	21.0	0.197 E-19
G327.6+14.5	SN 1006 A.D.	32.3	7.7	−0.57	34	0.419 E-20
G328.0+0.3		4.5	1	−0.55	6.4	0.165 E-19
G328.4+0.2	MSH 15−57	20	11	−0.24	4.0	0.188 E-18
G330.0+15.0	Lupus Loop	445			368	0.493 E-21
G330.2+1.0		8.6	4.0	−0.30	8.3	0.187 E-19
G332.0+0.2		14.1		(−0.44)	12.0	0.147 E-19
G332.4+0.1	MSH 16−51	40	11	−0.51	13.2	0.344 E-19
G332.4−0.4	RCW 103	44	11	−0.55	9.4	0.747 E-19
G335.2+0.1		27.1	8.6	−0.46	18.6	0.117 E-19
G336.7+0.5		9.7	(1.4)	−0.37	9.9	0.145 E-19
G337.0−0.1	CTB 33	26	(14.4)	−0.47	7.6	0.675 E-19
G337.2−0.7		3.8	0.7	−0.67	3.9	0.375 E-19

G337.3+1.0	Kes 40	24.6	7.2	−0.49	11.8	0.265E-19
G337.8−0.1	Kes 41	26	(7.2)	−0.51	10.6	0.347E-19
G338.2+0.4		(2.3)	(0.8)	−0.42	11.7	0.252E-20
G338.3−0.1		(12.5)	(2.4)	−0.66	8.2	0.279E-19
G338.5+0.1		(36.8)	(16.1)	−0.33	12.4	0.359E-19
G339.2−0.4		7.5	4.5	−0.20	9.9	0.115E-19
G340.4+0.4		8.2	2.9	−0.41	6.4	0.295E-19
G340.6+0.3		7.0	2.8	−0.36	4.9	0.437E-19
G341.9−0.3	MSH 16−48	7.4	1.7	−0.59	6.1	0.300E-19
G344.7−0.1		4.7	1.3	−0.51	7.8	0.116E-19
G346.6−0.2		14.9	4.3	−0.49	8.0	0.349E-19
G348.5+0.1	CTB 37A	97	39	(−0.33)	8.0	0.228E-18
G348.7+0.3	CTB 37B	34	22	(−0.30)	5.1	0.196E-18
G349.7+0.2		31	9.1	−0.49	1.7	0.156E-17
G350.0−1.8		49.5	13.6	−0.51	28.9	0.889E-20
G350.1−0.3		10.7	1.7	−0.73	4.1	0.964E-19
G351.2+0.1		8.1	3.1	−0.38	6.2	0.316E-19
G352.7−0.1		9.6	2.3	−0.57	6.4	0.347E-19
G355.9−2.5		12.3	3.4	−0.51	11.2	0.147E-19
G357.7−0.1	MSH 17−39	54.2	18.5	−0.43	5.2	0.301E-18
G4.5+6.8	Kepler's SN	33	7.1	−0.58	3.2	0.498E-18
G5.3−1.0	A 4	38	27	−0.2	15.0	0.253E-19
G6.4−0.1	W 28	460	179	−0.38	49	0.292E-19
G7.7−3.7		12.2	6.7	−0.25	19.5	0.481E-20
G10.0−0.3		1.9	(0.8)	−0.34	6.0	0.792E-20
G11.2−0.3		36	8.9	−0.56	4.2	0.306E-18
G11.4−0.1		9.4	2.8	−0.48	7.0	0.288E-19
G12.0−0.1		6.6	1.1	−0.71	5.4	0.339E-19
G15.9+0.2		7.7	1.9	−0.56	5.0	0.462E-19
G18.8+0.3	Kes 67	38	15	−0.36	15.0	0.213E-19
G21.8−0.6	Kes 69	110	28	−0.54	22.8	0.317E-19
G22.7−0.2		54		−0.57	24.6	0.134E-19
G23.3−0.3	W 41, Kes 70	92		−0.50	21.0	0.313E-19
G23.6+0.3		8.3			7.2	0.240E-19
G24.7+0.6		27		(−0.59)	14.0	0.207E-19
G24.7−0.6		12.3	3.6	−0.49	14.6	0.865E-20
G27.4+0.0	Kes 73	4.4	1.4	−0.45	4.4	0.341E-19
G29.7−0.2	Kes 75	19.5	3.3	−0.71	2.4	0.512E-18
G31.9+0.0	3C 391	34.4	9.8	−0.57	4.8	0.224E-18
G32.0−4.9	3C 396.1					
G32.8−0.1	Kes 78	12.8	7.7	−0.20	17.2	0.166E-19
G33.6+0.1	4C 00.70	35.5	7.8	−0.60	9.2	0.629E-19
G34.6−0.5	W 44	299	149	−0.28	27.2	0.606E-19
G39.2−0.3	3C 396	30	8.8	−0.49	6.6	0.103E-18
G39.7−2.0	W 50	>40			>30	
G41.1−0.3	3C 397	29.8	8.7	−0.49	3.6	0.341E-18
G41.9−4.1	PKS 1920+06			(−0.5)	164	0.169E-20
G43.3−0.2	W 49B	53	16	−0.47	4.2	0.450E-18
G46.8−0.3		20.2	7.1	−0.42	15.6	0.124E-19
G47.6+6.1	CTB 63				83.4	
G49.2−0.5	W 51	200		−0.25	26.6	0.424E-19
G53.7−2.2		11.7		(−0.32)	26.6	0.248E-20

Pulsars

Name (PSR)	1950.0 Right ascension	1950.0 Declination	gal. long.	gal. lat.	radio intensity (400 MHz) $S^{1)}$	equivalent pulse width$^{2)}$	period P	slow-down of period dP/dt	distance	Remark
	h m	° ′	°	°	Jy	msec	sec	10^{-15}sec/sec	10^4 l.y.	
0329+54	03 29.2	+54 25	145	−1	2.27	8.7	0.7145	2.05	0.85	S at maximum
0525+21	05 25.9	+21 58	184	−7	0.09	75	3.7454	40.06	0.62	longest period
0531+21	05 31.5	+21 59	185	−6	0.48	1.9	0.0331	422.69	0.65	Crab pulsar
0833−45	08 33.7	−45 00	264	−3	2.8	1.71	0.0892	125.03	0.16	Vela pulsar
1641−45	16 41.2	−45 54	339	−0	1.3	9	0.4550	20.10	1.60	
1749−28	17 49.8	−28 06	2	−1	1.07	7	0.5625	8.15	0.33	
1919+21	19 19.6	+21 47	56	+4	0.06	25	1.3373	1.34	0.13	first discovered

1) Radio intensity averaged over a period.
2) Equivalent pulse width is derived by dividing the pulse energy for the period by the peak flux.

γ-ray point sources

l^{II} (deg.)	b^{II} (deg.)	Error range$^{1)}$ (deg.)	Flux$^{2)}$ >100 MeV (photon·cm^{-2}·sec^{-1})	l^{II} (deg.)	b^{II} (deg.)	Error range$^{1)}$ (deg.)	Flux$^{2)}$ >100 MeV (photon·cm^{-2}·sec^{-1})
6.7	− 0.5	1.0	2.4×10^{-6}	235.5	− 1.0	1.5	1.0×10^{-6}
10.5	−31.5	1.5	1.	263.6	− 2.5	0.3	13.2
13.5	0.5	1.0	1.0	284.0	− 1.0	1.0	2.7
36.5	1.5	1.0	1.9	288.5	− 0.5	1.3	1.6
54.2	1.7	1.0	1.3	289.3	64.6	0.8	0.6
66.0	0.0	0.8	1.2	295.5	0.5	1.0	1.3
75.0	− 0.5	1.0	1.3	312.0	− 1.3	1.0	2.1
77.8	1.5	1.0	2.5	321.0	− 1.2	1.0	1.3
95.5	4.0	1.5	1.1	327.5	− 0.5	1.0	2.2
106.0	1.5	1.5	1.0	333.5	0.0	1.0	3.8
121.0	4.0	1.0	1.0	342.5	− 1.5	1.0	2.0
135.0	1.5	1.0	1.0	353.0	16.0	1.5	1.1
184.5	− 5.8	0.4	3.7	356.5	0.3	1.0	2.6
195.1	4.5	0.4	4.8	359.5	− 0.5	1.0	1.8
218.5	− 0.5	1.3	1.0				

1) Error range indicates the range of 90% reliability.
2) Flux is derived from the approximation as E^{-2} for spectral distributions.