γ

$I(J^{PC}) = 0,1(1^{--})$

γ MASS

For a review of the photon mass, see BYRNE 77.

VALUE (eV)	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
$< 2 \times 10^{-16}$		[1] LAKES	98		Torque on toroid balance
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$< 9 \times 10^{-16}$	90	[2] FISCHBACH	94		Earth magnetic field
$<(4.73\pm0.45) \times 10^{-12}$		[3] CHERNIKOV	92	SQID	Ampere-law null test
$<(9.0 \pm 8.1) \times 10^{-10}$		[4] RYAN	85		Coulomb-law null test
$< 3 \times 10^{-27}$		[5] CHIBISOV	76		Galactic magnetic field
$< 6 \times 10^{-16}$	99.7	DAVIS	75		Jupiter magnetic field
$< 7.3 \times 10^{-16}$		HOLLWEG	74		Alfven waves
$< 6 \times 10^{-17}$		[6] FRANKEN	71		Low freq. res. cir.
$< 1 \times 10^{-14}$		WILLIAMS	71	CNTR	Tests Gauss law
$< 2.3 \times 10^{-15}$		GOLDHABER	68		Satellite data
$< 6 \times 10^{-15}$		[6] PATEL	65		Satellite data
$< 6 \times 10^{-15}$		GINTSBURG	64		Satellite data

[1] LAKES 98 report limits on torque on a toroid Cavendish balance, obtaining a limit on μ^2***A*** via the Maxwell-Proca equations, where μ is the photon mass and ***A*** is the ambient vector potential in the Lorentz gauge. This is the most conservative limit reported, in which ***A***$\approx (1\,\mu\,\mathrm{G})\times(600\,\mathrm{pc})$ is based on the Galactic field.

[2] FISCHBACH 94 report $< 8 \times 10^{-16}$ with unknown CL. We report Baysian CL used elsewhere in these Listings and described in the Statistics section.

[3] CHERNIKOV 92 measures the photon mass at 1.24 K, following a theoretical suggestion that electromagnetic gauge invariance might break down at some low critical temperature. See the erratum for a correction, included here, to the published result.

[4] RYAN 85 measures the photon mass at 1.36 K (see the footnote to CHERNIKOV 92).

[5] CHIBISOV 76 depends in critical way on assumptions such as applicabilty of virial theorem. Some of the arguments given only in unpublished references.

[6] See criticism questioning the validity of these results in KROLL 71 and GOLDHABER 71.

γ CHARGE

VALUE (*e*)	*DOCUMENT ID*		*TECN*	*COMMENT*
$<5 \times 10^{-30}$	[7] RAFFELT	94	TOF	Pulsar $f_1 - f_2$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$<2 \times 10^{-28}$	[8] COCCONI	92		VLBA radio telescope resolution
$<2 \times 10^{-32}$	COCCONI	88	TOF	Pulsar $f_1 - f_2$ TOF

[7] RAFFELT 94 notes that COCCONI 88 neglects the fact that the time delay due to dispersion by free electrons in the interstellar medium has the same photon energy dependence as that due to bending of a charged photon in the magnetic field. His limit is based on the assumption that the entire observed dispersion is due to photon charge. It is a factor of 200 less stringent than the COCCONI 88 limit.

[8] See COCCONI 92 for less stringent limits in other frequency ranges. Also see RAFFELT 94 note.

γ REFERENCES

LAKES	98	PRL 80 1826	R. Lakes	(WISC)
FISCHBACH	94	PRL 73 514	E. Fischbach *et al.*	(PURD, JHU+)
RAFFELT	94	PR D50 7729	G. Raffelt	(MPIM)
CHERNIKOV	92	PRL 68 3383	M.A. Chernikov *et al.*	(ETH)
Also	92B	PRL 69 2999 (erratum)	M.A. Chernikov *et al.*	(ETH)
COCCONI	92	AJP 60 750	G. Cocconi	(CERN)
COCCONI	88	PL B206 705	G. Cocconi	(CERN)
RYAN	85	PR D32 802	J.J. Ryan, F. Accetta, R.H. Austin	(PRIN)
BYRNE	77	Ast.Sp.Sci. 46 115	J. Byrne	(LOIC)
CHIBISOV	76	SPU 19 624	G.V. Chibisov	(LEBD)
DAVIS	75	PRL 35 1402	L. Davis, A.S. Goldhaber, M.M. Nieto	(CIT, STON+)
HOLLWEG	74	PRL 32 961	J.V. Hollweg	(NCAR)
FRANKEN	71	PRL 26 115	P.A. Franken, G.W. Ampulski	(MICH)
GOLDHABER	71	RMP 43 277	A.S. Goldhaber, M.M. Nieto	(STON, BOHR, UCSB)
KROLL	71	PRL 26 1395	N.M. Kroll	(SLAC)
WILLIAMS	71	PRL 26 721	E.R. Williams, J.E. Faller, H.A. Hill	(WESL)
GOLDHABER	68	PRL 21 567	A.S. Goldhaber, M.M. Nieto	(STON)
PATEL	65	PL 14 105	V.L. Patel	(DUKE)
GINTSBURG	64	Sov. Astr. AJ7 536	M.A. Gintsburg	(ASCI)