graviton

$J = 2$

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graviton MASS

Van Dam and Veltman (VANDAM 70), Iwasaki (IWASAKI 70), and Zakharov (ZAKHAROV 70) almost simultanously showed that "... there is a discrete difference between the theory with zero-mass and a theory with finite mass, no matter how small as compared to all external momenta." The resolution of this "vDVZ discontinuity" has to do with whether the linear approximation is valid. De Rham *etal*. (DE-RHAM 11) have shown that nonlinear effects not captured in their linear treatment can give rise to a screening mechanism, allowing for massive gravity theories. See also GOLDHABER 10 and DE-RHAM 17 and references therein. Experimental limits have been set based on a Yukawa potential or signal dispersion. h_0 is the Hubble constant in units of 100 km s^{-1} Mpc^{-1}.

The following conversions are useful: $1\ \text{eV} = 1.783 \times 10^{-33}\ \text{g} = 1.957 \times 10^{-6}\ m_e$; $\lambda\!\!\!^{-}_C = (1.973 \times 10^{-7}\ \text{m}) \times (1\ \text{eV}/m_g)$.

VALUE (eV)	*DOCUMENT ID*		*TECN*	*COMMENT*
$\mathbf{<6 \times 10^{-32}}$	[1] CHOUDHURY	04	YUKA	Weak gravitational lensing
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$<1.4 \times 10^{-29}$	[2] DESAI	18	YUKA	Gal cluster Abell 1689
$<5 \times 10^{-30}$	[3] GUPTA	18	YUKA	SPT-SZ
$<3 \times 10^{-30}$	[3] GUPTA	18	YUKA	Planck all-sky SZ
$<1.3 \times 10^{-29}$	[3] GUPTA	18	YUKA	redMaPPer SDSS-DR8
$<6 \times 10^{-30}$	[4] RANA	18	YUKA	Weak lensing in massive clusters
$<8 \times 10^{-30}$	[5] RANA	18	YUKA	SZ effect in massive clusters
$<7 \times 10^{-23}$	[6] ABBOTT	17	DISP	Combined dispersion limit from three BH mergers
$<1.2 \times 10^{-22}$	[6] ABBOTT	16	DISP	Combined dispersion limit from two BH mergers
$<2.9 \times 10^{-21}$	[7] ZAKHAROV	16	YUKA	S2 star orbit
$<5 \times 10^{-23}$	[8] BRITO	13		Spinning black holes bounds
$<4 \times 10^{-25}$	[9] BASKARAN	08		Graviton phase velocity fluctuations
$<6 \times 10^{-32}$	[10] GRUZINOV	05	YUKA	Solar System observations
$<9.0 \times 10^{-34}$	[11] GERSHTEIN	04		From Ω_{tot} value assuming RTG
$>6 \times 10^{-34}$	[12] DVALI	03		Horizon scales
$<8 \times 10^{-20}$	[13,14] FINN	02	DISP	Binary pulsar orbital period decrease
	[14,15] DAMOUR	91		Binary pulsar PSR 1913+16
$<7 \times 10^{-23}$	TALMADGE	88	YUKA	Solar system planetary astrometric data
$< 2 \times 10^{-29}\ h_0^{-1}$	GOLDHABER	74		Rich clusters
$<7 \times 10^{-28}$	HARE	73		Galaxy
$<8 \times 10^{4}$	HARE	73		2γ decay

[1] CHOUDHURY 04 concludes from a study of weak-lensing data that masses heavier than about the inverse of 100 Mpc seem to be ruled out if the gravitation field has the Yukawa form.

[2] DESAI 18 limit based on dynamical mass models of galaxy cluster Abell 1689.

[3] GUPTA 18 obtains graviton mass limits using stacked clusters from 3 disparate surveys.

[4] RANA 18 limit, 68% CL, obtained using weak lensing mass profiles out to the radius at which the cluster density falls to 200 times the critical density of the Universe. Limit is based on the fractional change between Newtonian and Yukawa accelerations for the 50 most massive galaxy clusters in the Local Cluster Substructure Survey. Limits for other CL's and other density cuts are also given.

[5] RANA 18 limit, 68% CL, obtained using mass measurements via the SZ effect out to the radius at which the cluster density falls to 500 times the critical density of the Universe for 182 optically confirmed galaxy clusters in an Altacama Cosmology Telescope survey. Limits for other CL's and other density cuts are also given.

[6] ABBOTT 16 and ABBOTT 17 assumed a dispersion relation for gravitational waves modified relative to GR.

[7] ZAKHAROV 16 constrains range of Yukawa gravity interaction from S2 star orbit about black hole at Galactic center. The limit is $< 2.9 \times 10^{-21}$ eV for $\delta = 100$.

[8] BRITO 13 explore massive graviton (spin-2) fluctuations around rotating black holes.

[9] BASKARAN 08 consider fluctuations in pulsar timing due to photon interactions ("surfing") with background gravitational waves.

[10] GRUZINOV 05 uses the DGP model (DVALI 00) showing that non-perturbative effects restore continuity with Einstein's equations as the gravition mass approaches 0, then bases his limit on Solar System observations.

[11] GERSHTEIN 04 use non-Einstein field relativistic theory of gravity (RTG), with a massive graviton, to obtain the 95% CL mass limit implied by the value of $\Omega_{tot} = 1.02 \pm 0.02$ current at the time of publication.

[12] DVALI 03 suggest scale of horizon distance via DGP model (DVALI 00). For a horizon distance of 3×10^{26} m (about age of Universe/*c*; GOLDHABER 10) this graviton mass limit is implied.

[13] FINN 02 analyze the orbital decay rates of PSR B1913+16 and PSR B1534+12 with a possible graviton mass as a parameter. The combined frequentist mass limit is at 90%CL.

[14] As of 2014, limits on dP/dt are now about 0.1% (see T. Damour, "Experimental tests of gravitational theory," in this *Review*).

[15] DAMOUR 91 is an analysis of the orbital period change in binary pulsar PSR 1913+16, and confirms the general relativity prediction to 0.8%. "The theoretical importance of the [rate of orbital period decay] measurement has long been recognized as a direct confirmation that the gravitational interaction propagates with velocity *c* (which is the immediate cause of the appearance of a damping force in the binary pulsar system) and thereby as a test of the existence of gravitational radiation and of its quadrupolar nature." TAYLOR 93 adds that orbital parameter studies now agree with general relativity to 0.5%, and set limits on the level of scalar contribution in the context of a family of tensor [spin 2]-biscalar theories.

graviton REFERENCES

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