Reference = ADLER 02C; PL B537 211
Verifier code = BNL-787

Normally we send all verifications for one experiment to one person, usually the spokesperson or data-analysis coordinator, who then distributes them to the appropriate people. Please tell us if we should send the verifications for your experiment to someone else.

PLEASE READ NOW

PLEASE REPLY WITHIN THREE DAYS VIA FAX

L.S. Littenberg
Brookhaven National Lab.
Physics Department
PO Box 5000
Upton, NY 11973-5000
USA

March 31, 2003

Dear Colleague,

The attached sheets from the "Review of Particle Physics" Particle Listings contain information from your experiment that was recently added to our database. There may be other papers that we have not yet added to the Listings; please feel free to inform us of any journal papers or preprints if they have been accepted for publication. You are the *only* author of this paper to whom this request is being sent, so please forward this to another author if appropriate.

We ask you to check the information marked "YOUR DATA" and "YOUR PAPER," note any necessary changes, and return the corrected sheets to us. In particular:

(1) Return the sheets to us *even if no change is needed*, marking them in that case "OK."

(2) Please feel free to comment on our treatment of other data listed on these sheets. We appreciate suggestions for improvements.

(3) You may respond by electronic mail, but then be sure to include the "Reference" above and the **NAME** of the particle, the **PROPERTY**, and the **PROPERTY NODE** on which you are commenting. (The "**PROPERTY NODE**" is the code given on the right-hand side of the data, *e.g.*, "`NODE=S043M`.")

Thank you for helping us make the Review accurate and useful.

Sincerely,

Michael Barnett
MS 50R6008
Lawrence Berkeley National Lab.
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Axions (A^0) and Other Very Light Bosons, Searches for

NODE=S029

A^0 (Axion) and Other Light Boson (X^0) Searches in Meson Decays

NODE=S029AD2

Limits are for branching ratios.

NODE=S029AD2
NODE=S029AD2

	VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT	
	• • • We do not use the following data for averages, fits, limits, etc. • • •							
YOUR DATA	$<4.5 \times 10^{-11}$	90		[3] ADLER	02C	B787	$K^+ \to \pi^+ A^0$	
	$<4.9 \times 10^{-5}$	90		AMMAR	01B	CLEO	$B^\pm \to \pi^\pm(K^\pm)A^0$	
	$<5.3 \times 10^{-5}$	90		AMMAR	01B	CLEO	$B^0 \to K^0_S A^0$	OCCUR=2
	$<1.1 \times 10^{-10}$	90		[4] ADLER	00	B787	$K^+ \to \pi^+ A^0$	
	$<3.3 \times 10^{-5}$	90		[5] ALTEGOER	98	NOMD	$\pi^0 \to \gamma X^0$, $m_{X^0} < 120$ MeV	
	$<5.0 \times 10^{-8}$	90		[6] KITCHING	97	B787	$K^+ \to \pi^+ A^0$ $(A^0 \to \gamma\gamma)$	
	$<5.2 \times 10^{-10}$	90		[7] ADLER	96	B787	$K^+ \to \pi^+ A^0$	
	$<2.8 \times 10^{-4}$	90		[8] AMSLER	96B	CBAR	$\pi^0 \to \gamma X^0$, $m_{X^0} < 65$ MeV	
	$<3 \times 10^{-4}$	90		[8] AMSLER	96B	CBAR	$\eta \to \gamma X^0$, m_{X^0}= 50–200 MeV	OCCUR=2
	$<4 \times 10^{-5}$	90		[8] AMSLER	96B	CBAR	$\eta' \to \gamma X^0$, m_{X^0}= 50–925 MeV	OCCUR=3
	$<6 \times 10^{-5}$	90		[8] AMSLER	94B	CBAR	$\pi^0 \to \gamma X^0$, m_{X^0}=65–125 MeV	
	$<6 \times 10^{-5}$	90		[8] AMSLER	94B	CBAR	$\eta \to \gamma X^0$, m_{X^0}=200–525 MeV	OCCUR=2
	<0.007	90		[9] MEIJERDREES	94	CNTR	$\pi^0 \to \gamma X^0$, m_{X^0}=25 MeV	
	<0.002	90		[9] MEIJERDREES	94	CNTR	$\pi^0 \to \gamma X^0$, m_{X^0}=100 MeV	OCCUR=2
	$<2 \times 10^{-7}$	90		[10] ATIYA	93B	B787	$K^+ \to \pi^+ A^0$	
	$<3 \times 10^{-13}$			[11] NG	93	COSM	$\pi^0 \to \gamma X^0$	
	$<1.1 \times 10^{-8}$	90		[12] ALLIEGRO	92	SPEC	$K^+ \to \pi^+ A^0$ $(A^0 \to e^+ e^-)$	
	$<5 \times 10^{-4}$	90		[13] ATIYA	92	B787	$\pi^0 \to \gamma X^0$	
	$<4 \times 10^{-6}$	90		[14] MEIJERDREES	92	SPEC	$\pi^0 \to \gamma X^0$, $X^0 \to e^+ e^-$, m_{x^0}= 100 MeV	
	$<1 \times 10^{-7}$	90		[15] ATIYA	90B	B787	Sup. by KITCHING 97	
	$<1.3 \times 10^{-8}$	90		[16] KORENCHE...	87	SPEC	$\pi^+ \to e^+ \nu A^0$ $(A^0 \to e^+ e^-)$	
	$<1 \times 10^{-9}$	90	0	[17] EICHLER	86	SPEC	Stopped $\pi^+ \to e^+ \nu A^0$	OCCUR=2
	$<2 \times 10^{-5}$	90		[18] YAMAZAKI	84	SPEC	For 160<m<260 MeV	
	$<(1.5–4) \times 10^{-6}$	90		[18] YAMAZAKI	84	SPEC	K decay, $m_{A^0} \ll$ 100 MeV	OCCUR=2
			0	[19] ASANO	82	CNTR	Stopped $K^+ \to \pi^+ A^0$	
			0	[20] ASANO	81B	CNTR	Stopped $K^+ \to \pi^+ A^0$	
				[21] ZHITNITSKII	79		Heavy axion	

[3] ADLER 02C bound is for m_{A^0} <60 MeV. See Fig. 2 for limits at higher masses.

NODE=S029AD2;LINKAGE=LC

[4] ADLER 00 bound is for massless A^0.

NODE=S029AD2;LINKAGE=TD

[5] ALTEGOER 98 looked for X^0 from π^0 decay which penetrate the shielding and convert to π^0 in the external Coulomb field of a nucleus.

NODE=S029AD2;LINKAGE=M

[6] KITCHING 97 limit is for B($K^+ \to \pi^+ A^0$)·B($A^0 \to \gamma\gamma$) and applies for $m_{A^0} \simeq 50$ MeV, $\tau_{A^0} < 10^{-10}$ s. Limits are provided for 0<m_{A^0} < 100 MeV, $\tau_{A^0} < 10^{-8}$ s.

NODE=S029AD2;LINKAGE=TK

[7] ADLER 96 looked for a peak in missing-mass distribution. This work is an update of ATIYA 93. The limit is for massless stable A^0 particles and extends to m_{A^0}=80 MeV at the same level. See paper for dependence on finite lifetime.

NODE=S029AD2;LINKAGE=K4

[8] AMSLER 94B and AMSLER 96B looked for a peak in missing-mass distribution. NODE=S029AD2;LINKAGE=K

[9] The MEIJERDREES 94 limit is based on inclusive photon spectrum and is independent of X^0 decay modes. It applies to $\tau(X^0) > 10^{-23}$ sec. NODE=S029AD2;LINKAGE=L

[10] ATIYA 93B looked for a peak in missing mass distribution. The bound applies for stable A^0 of m_{A^0}=150–250 MeV, and the limit becomes stronger (10^{-8}) for m_{A^0}=180–240 MeV. NODE=S029AD2;LINKAGE=I2

[11] NG 93 studied the production of X^0 via $\gamma\gamma \rightarrow \pi^0 \rightarrow \gamma X^0$ in the early universe at $T \simeq 1$ MeV. The bound on extra neutrinos from nucleosyntheis $\Delta N_\nu < 0.3$ (WALKER 91) is employed. It applies to $m_{X^0} \ll 1$ MeV in order to be relativistic down to nucleosynthesis temperature. See paper for heavier X^0. NODE=S029AD2;LINKAGE=J

[12] ALLIEGRO 92 limit applies for m_{A^0}=150–340 MeV and is the branching ratio times the decay probability. Limit is $< 1.5 \times 10^{-8}$ at 99%CL. NODE=S029AD2;LINKAGE=F

[13] ATIYA 92 looked for a peak in missing mass distribution. The limit applies to m_{X^0}=0–130 MeV in the narrow resonance limit. See paper for the dependence on lifetime. Covariance requires X^0 to be a vector particle. NODE=S029AD2;LINKAGE=H

[14] MEIJERDREES 92 limit applies for $\tau_{X^0} = 10^{-23}$–10^{-11} sec. Limits between 2×10^{-4} and 4×10^{-6} are obtained for m_{X^0} = 25–120 MeV. Angular momentum conservation requires that X^0 has spin ≥ 1. NODE=S029AD2;LINKAGE=E

[15] ATIYA 90B limit is for $B(K^+ \rightarrow \pi^+ A^0) \cdot B(A^0 \rightarrow \gamma\gamma)$ and applies for $m_{A^0} = 50$ MeV, $\tau_{A^0} < 10^{-10}$ s. Limits are also provided for $0 < m_{A^0} < 100$ MeV, $\tau_{A^0} < 10^{-8}$ s. NODE=S029AD2;LINKAGE=K2

[16] KORENCHENKO 87 limit assumes $m_{A^0} = 1.7$ MeV, $\tau_{A^0} \lesssim 10^{-12}$ s, and $B(A^0 \rightarrow e^+ e^-) = 1$. NODE=S029AD2;LINKAGE=A

[17] EICHLER 86 looked for $\pi^+ \rightarrow e^+ \nu A^0$ followed by $A^0 \rightarrow e^+ e^-$. Limits on the branching fraction depend on the mass and and lifetime of A^0. The quoted limits are valid when $\tau(A^0) \gtrsim 3. \times 10^{-10}$s if the decays are kinematically allowed. NODE=S029AD2;LINKAGE=T

[18] YAMAZAKI 84 looked for a discrete line in $K^+ \rightarrow \pi^+ X$. Sensitive to wide mass range (5–300 MeV), independent of whether X decays promptly or not. NODE=S029AD2;LINKAGE=R

[19] ASANO 82 at KEK set limits for $B(K^+ \rightarrow \pi^+ A^0)$ for m_{A^0} <100 MeV as BR $< 4. \times 10^{-8}$ for $\tau(A^0 \rightarrow n\gamma\text{'s}) > 1. \times 10^{-9}$ s, BR $< 1.4 \times 10^{-6}$ for $\tau < 1. \times 10^{-9}$s. NODE=S029AD2;LINKAGE=G

[20] ASANO 81B is KEK experiment. Set $B(K^+ \rightarrow \pi^+ A^0) < 3.8 \times 10^{-8}$ at CL = 90%. NODE=S029AD2;LINKAGE=C

[21] ZHITNITSKII 79 argue that a heavy axion predicted by YANG 78 ($3 < m < 40$ MeV) contradicts experimental muon anomalous magnetic moments. NODE=S029AD2;LINKAGE=B

REFERENCES FOR Searches for Axions (A^0) and Other Very Light Bosons

NODE=S029

YOUR PAPER	ADLER	02C	PL B537 211	S. Adler *et al.*	(BNL E787 Collab.)	REFID=48768
	AMMAR	01B	PRL 87 271801	R. Ammar *et al.*	(CLEO Collab.)	REFID=48534
	ADLER	00	PRL 84 3768	S. Adler *et al.*	(BNL E787 Collab.)	REFID=47539
	ALTEGOER	98	PL B428 197	J. Altegoer *et al.*		REFID=46060
	KITCHING	97	PRL 79 4079	P. Kitching *et al.*	(BNL E787 Collab.)	REFID=45721
	ADLER	96	PRL 76 1421	S. Adler *et al.*	(BNL E787 Collab.)	REFID=44723
	AMSLER	96B	ZPHY C70 219	C. Amsler *et al.*	(Crystal Barrel Collab.)	REFID=44819
	AMSLER	94B	PL B333 271	C. Amsler *et al.*	(Crystal Barrel Collab.)	REFID=43903
	MEIJERDREES	94	PR D49 4937	M.R. Drees *et al.*	(BRCO, OREG, TRIU)	REFID=43858
	ATIYA	93	PRL 70 2521	M.S. Atiya *et al.*	(BNL E787 Collab.)	REFID=43262
	Also	93C	PRL 71 305 (erratum)	M.S. Atiya *et al.*	(BNL E787 Collab.)	REFID=43449
	ATIYA	93B	PR D48 R1	M.S. Atiya *et al.*	(BNL E787 Collab.)	REFID=43331
	NG	93	PR D48 2941	K.W. Ng	(AST)	REFID=43529
	ALLIEGRO	92	PRL 68 278	C. Alliegro *et al.*	(BNL, FNAL, PSI+)	REFID=41961
	ATIYA	92	PRL 69 733	M.S. Atiya *et al.*	(BNL, LANL, PRIN+)	REFID=42140
	MEIJERDREES	92	PRL 68 3845	R. Meijer Drees *et al.*	(SINDRUM I Collab.)	REFID=42044
	WALKER	91	APJ 376 51	T.P. Walker *et al.*	(HSCA, OSU, CHIC+)	REFID=41879
	ATIYA	90B	PRL 65 1188	M.S. Atiya *et al.*	(BNL E787 Collab.)	REFID=41282
	KORENCHE...	87	SJNP 46 192	S.M. Korenchenko *et al.*	(JINR)	REFID=40461
			Translated from YAF 46 313.			
	EICHLER	86	PL B175 101	R.A. Eichler *et al.*	(SINDRUM Collab.)	REFID=40134
	YAMAZAKI	84	PRL 52 1089	T. Yamazaki *et al.*	(INUS, KEK)	REFID=12489
	ASANO	82	PL 113B 195	Y. Asano *et al.*	(KEK, TOKY, INUS, OSAK)	REFID=11013
	ASANO	81B	PL 107B 159	Y. Asano *et al.*	(KEK, TOKY, INUS, OSAK)	REFID=11008
	ZHITNITSKII	79	SJNP 29 517	A.R. Zhitnitsky, Y.I. Skovpen	(NOVO)	REFID=12462
			Translated from YAF 29 1001.			
	YANG	78	PRL 41 523	T.C. Yang	(MASA)	REFID=40525