Magnetic Monopole Searches

NODE=S028

See the related review(s):

Magnetic Monopoles

Monopole Production Cross Section — Accelerator Searches

NODE=S028C
NODE=S028C

X-SECT (cm^2)	MASS (GeV)	CHG (g)	ENERGY (GeV)	BEAM	DOCUMENT ID		TECN	
<1.45E-30	60	1	5360	PbPb	[1] AAD	25B	ATLS	
<1E-39-1E-35		1–10	13000	pp	[2] ACHARYA	25	MOED	
	0–80	1–50	2760	PbPb	[3] ACHARYA	24	INDU	
<4 E-41	200–4000	1–2	13000	pp	[4] AAD	23CO	ATLS	
<4 E-38	590–1000	1–4	8000	pp	[5] ACHARYA	22A	INDU	
<2 E-29	0–70	1–3	5020	PbPb	[6] ACHARYA	22B	INDU	
<3 E-38	750–1910	1–5	13000	pp	[7] ACHARYA	21	INDU	
<1.3E−40	200–4000	1	13000	pp	[8] AAD	20G	ATLS	
<5.6E−40	500–4000	2	13000	pp	[8] AAD	20G	ATLS	OCCUR=2
	200–5000	2	13000	pp	[9] ACHARYA	19B	INDU	OCCUR=2
	200–5000	1	13000	pp	[10] ACHARYA	18A	INDU	
<2.5E−37	200–6000	1	13000	pp	[11] ACHARYA	17	INDU	
<2E−37	200–6000	2	13000	pp	[11] ACHARYA	17	INDU	OCCUR=2
<4E−37	200–5000	3	13000	pp	[11] ACHARYA	17	INDU	OCCUR=3
<1.5E−36	400–4000	4	13000	pp	[11] ACHARYA	17	INDU	OCCUR=4
<7E−36	1000–3000	5	13000	pp	[11] ACHARYA	17	INDU	OCCUR=5
<5E−40	200–2500	0.5–2.0	8000	pp	[12] AAD	16AB	ATLS	
<2E−37	100–3500	1	8000	pp	[13] ACHARYA	16	INDU	
<2E−37	100–3500	2	8000	pp	[13] ACHARYA	16	INDU	OCCUR=2
<6E−37	500–3000	3	8000	pp	[13] ACHARYA	16	INDU	OCCUR=3
<7E−36	1000–2000	4	8000	pp	[13] ACHARYA	16	INDU	OCCUR=4
<1.6E−38	200–1200	1	7000	pp	[14] AAD	12CS	ATLS	
<5E−38	45–102	1	206	e^+e^-	[15] ABBIENDI	08	OPAL	
<0.2E−36	200–700	1	1960	$p\overline{p}$	[16] ABULENCIA	06K	CNTR	
< 2.E−36		1	300	e^+p	[17,18] AKTAS	05A	INDU	
< 0.2 E−36		2	300	e^+p	[17,18] AKTAS	05A	INDU	OCCUR=2
< 0.09E−36		3	300	e^+p	[17,18] AKTAS	05A	INDU	OCCUR=3
< 0.05E−36		≥ 6	300	e^+p	[17,18] AKTAS	05A	INDU	OCCUR=4
< 2.E−36		1	300	e^+p	[17,19] AKTAS	05A	INDU	OCCUR=5
< 0.2E−36		2	300	e^+p	[17,19] AKTAS	05A	INDU	OCCUR=6
< 0.07E−36		3	300	e^+p	[17,19] AKTAS	05A	INDU	OCCUR=7
< 0.06E−36		≥ 6	300	e^+p	[17,19] AKTAS	05A	INDU	OCCUR=8
< 0.6E−36	>265	1	1800	$p\overline{p}$	[20] KALBFLEISCH	04	INDU	
< 0.2E−36	>355	2	1800	$p\overline{p}$	[20] KALBFLEISCH	04	INDU	OCCUR=2
< 0.07E−36	>410	3	1800	$p\overline{p}$	[20] KALBFLEISCH	04	INDU	OCCUR=3
< 0.2E−36	>375	6	1800	$p\overline{p}$	[20] KALBFLEISCH	04	INDU	OCCUR=4
< 0.7E−36	>295	1	1800	$p\overline{p}$	[21,22] KALBFLEISCH	00	INDU	
< 7.8E−36	>260	2	1800	$p\overline{p}$	[21,22] KALBFLEISCH	00	INDU	OCCUR=2
< 2.3E−36	>325	3	1800	$p\overline{p}$	[21,23] KALBFLEISCH	00	INDU	OCCUR=3
< 0.11E−36	>420	6	1800	$p\overline{p}$	[21,23] KALBFLEISCH	00	INDU	OCCUR=4
<0.65E−33	<3.3	≥ 2	11A	^{197}Au	[24,25] HE	97		
<1.90E−33	<8.1	≥ 2	160A	^{208}Pb	[24,25] HE	97		OCCUR=2
<3.E−37	<45.0	1.0	88–94	e^+e^-	PINFOLD	93	PLAS	
<3.E−37	<41.6	2.0	88–94	e^+e^-	PINFOLD	93	PLAS	OCCUR=2
<7.E−35	<44.9	0.2–1.0	89–93	e^+e^-	KINOSHITA	92	PLAS	
<2.E−34	<850	≥ 0.5	1800	$p\overline{p}$	BERTANI	90	PLAS	
<1.2E−33	<800	≥ 1	1800	$p\overline{p}$	PRICE	90	PLAS	
<1.E−37	<29	1	50–61	e^+e^-	KINOSHITA	89	PLAS	
<1.E−37	<18	2	50–61	e^+e^-	KINOSHITA	89	PLAS	OCCUR=2
<1.E−38	<17	<1	35	e^+e^-	BRAUNSCH...	88B	CNTR	
<8.E−37	<24	1	50–52	e^+e^-	KINOSHITA	88	PLAS	
<1.3E−35	<22	2	50–52	e^+e^-	KINOSHITA	88	PLAS	OCCUR=2
<9.E−37	<4	<0.15	10.6	e^+e^-	GENTILE	87	CLEO	
<3.E−32	<800	≥ 1	1800	$p\overline{p}$	PRICE	87	PLAS	
<3.E−38		<3	29	e^+e^-	FRYBERGER	84	PLAS	
<1.E−31		1,3	540	$p\overline{p}$	AUBERT	83B	PLAS	
<4.E−38	<10	<6	34	e^+e^-	MUSSET	83	PLAS	

<8.E−36	<20		52	$p p$	[26] DELL	82	CNTR
<9.E−37	<30	<3	29	$e^+ e^-$	KINOSHITA	82	PLAS
<1.E−37	<20	<24	63	$p p$	CARRIGAN	78	CNTR
<1.E−37	<30	<3	56	$p p$	HOFFMANN	78	PLAS
			62	$p p$	[26] DELL	76	SPRK
<4.E−33			300	p	[26] STEVENS	76B	SPRK
<1.E−40	<5	<2	70	p	[27] ZRELOV	76	CNTR
<2.E−30			300	n	[26] BURKE	75	OSPK
<1.E−38			8	ν	[28] CARRIGAN	75	HLBC
<5.E−43	<12	<10	400	p	EBERHARD	75B	INDU
<2.E−36	<30	<3	60	$p p$	GIACOMELLI	75	PLAS
<5.E−42	<13	<24	400	p	CARRIGAN	74	CNTR
<6.E−42	<12	<24	300	p	CARRIGAN	73	CNTR
<2.E−36		1	0.001	γ	[27] BARTLETT	72	CNTR
<1.E−41	<5		70	p	GUREVICH	72	EMUL
<1.E−40	<3	<2	28	p	AMALDI	63	EMUL
<2.E−40	<3	<2	30	p	PURCELL	63	CNTR
<1.E−35	<3	<4	28	p	FIDECARO	61	CNTR
<2.E−35	<1	1	6	p	BRADNER	59	EMUL

[1] AAD 25B searches are made for monopoles produced in ultra-peripheral PbPb collisions. Model-dependent mass exclusions between 20–150 GeV are made. Limit given at the mass of 60 GeV. NODE=S028C;LINKAGE=DA

[2] ACHARYA 25 present cross section and mass limits presented for a suite of searches covering charges between 1 and 10 Dirac charges and interpreted within various model scenarios. NODE=S028C;LINKAGE=EA

[3] ACHARYA 24 search for monopoles produced by the Schwinger mechanism. Results are model dependent. NODE=S028C;LINKAGE=CA

[4] AAD 23CO limits given for monopoles pair produced via a Drell-Yan or photon-fusion mechanism. Spins 1/2 and 0 are considered. The quoted limit is representative of the lowest values that were achieved. NODE=S028C;LINKAGE=BA

[5] ACHARYA 22A give limits for monopoles pair-produced via a Drell-Yan production. Spins 0, 1/2, and 1 are considered. The cross section limit is representative of the lowest values that were achieved. The experiment used a combination of nuclear track detectors to look evidence of passing monopoles and a SQUID magnetometer to look for stopped monopoles. NODE=S028C;LINKAGE=Y

[6] ACHARYA 22B achieved limits on monopole (point-like included) production via the Schwinger mechanism in Pb-Pb collisions at 5.02 TeV centre-of-mass energy per nucleon pair. The upper cross section limit value quoted here is representative of the lowest values achieved. NODE=S028C;LINKAGE=Z

[7] ACHARYA 21 search for dyons at LHC. Using a production model limits (we report the lowest) are set for dyons with magnetic charge up to 5 gD, electric charges up to 200 e and spins 0, 1/2, 1. The corresponding mass limits for magnetic monopoles are in the range 870–2040 GeV for magnetic charges in the same range. NODE=S028C;LINKAGE=X

[8] AAD 20G give limits for Drell-Yan production with spin-0 and spin-1/2 monopoles. The above limit is for spin = 0 at mass = 3 TeV. NODE=S028C;LINKAGE=V

[9] ACHARYA 19B limits both β-dependent and β-independent on monopoles with spins 0, 1/2, and 1 and with magnetic charges ranging from one to five times the Dirac charge in mass ranges between 200 GeV and 5000 GeV. NODE=S028C;LINKAGE=P

[10] ACHARYA 18A provide limits on monopoles with spins 0, 1/2, and 1 and with magnetic charges ranging from two to five times the Dirac charge. NODE=S028C;LINKAGE=J

[11] The search was sensitive to monopoles which had stopped in aluminium trapping volumes. Monopoles with spins 0 and 1/2 were considered; mass-dependent spin 1/2 monopole limits are quoted here. NODE=S028C;LINKAGE=G

[12] AAD 16AB model-independent 95% CL limits estimated using a fiducial region of approximately constant acceptance. Limits are mass-dependent. NODE=S028C;LINKAGE=E

[13] ACHARYA 16 limits at 95% CL estimated using a Drell-Yan-like production mechanism for scalar monopoles. NODE=S028C;LINKAGE=F

[14] AAD 12CS searched for monopoles as highly ionising objects. The cross section limits are based on an assumed Drell Yan-like production process for spin 1/2 monopoles. The limits are mass- and scenario-dependent. NODE=S028C;LINKAGE=AA

[15] ABBIENDI 08 assume production of spin 1/2 monopoles with effective charge $g\beta$ (n=1), via $e^+ e^- \rightarrow \gamma^* \rightarrow M\overline{M}$, so that the cross section is proportional to $(1 + \cos^2\theta)$. There is no z information for such highly saturated tracks, so a parabolic track in the jet chamber is projected onto the xy plane. Charge per hit in the chamber produces a clean separation of signal and background. NODE=S028C;LINKAGE=AB

[16] ABULENCIA 06K searches for high-ionizing signals in CDF central outer tracker and time-of-flight detector. For Drell-Yan $M\overline{M}$ production, the cross section limit implies $M > 360$ GeV at 95% CL. NODE=S028C;LINKAGE=UA

[17] AKTAS 05A model-dependent limits as a function of monopole mass shown for arbitrary mass of 60 GeV. Based on search for stopped monopoles in the H1 Al beam pipe. NODE=S028C;LINKAGE=AK

[18] AKTAS 05A limits with assumed elastic spin 0 monopole pair production. NODE=S028C;LINKAGE=AS

[19] AKTAS 05A limits with assumed inelastic spin 1/2 monopole pair production. NODE=S028C;LINKAGE=AT

[20] KALBFLEISCH 04 reports searches for stopped magnetic monopoles in Be, Al, and Pb samples obtained from discarded material from the upgrading of DØ and CDF. A large-aperture warm-bore cryogenic detector was used. The approach was an extension of NODE=S028C;LINKAGE=KL

the methods of KALBFLEISCH 00. Cross section results moderately model dependent; interpretation as a mass lower limit depends on possibly invalid perturbation expansion.

[21] KALBFLEISCH 00 used an induction method to search for stopped monopoles in pieces of the DØ (FNAL) beryllium beam pipe and in extensions to the drift chamber aluminum support cylinder. Results are model dependent. NODE=S028C;LINKAGE=KA

[22] KALBFLEISCH 00 result is for aluminum. NODE=S028C;LINKAGE=KB

[23] KALBFLEISCH 00 result is for beryllium. NODE=S028C;LINKAGE=KC

[24] HE 97 used a lead target and barium phosphate glass detectors. Cross-section limits are well below those predicted via the Drell-Yan mechanism. NODE=S028C;LINKAGE=HE

[25] This work has also been reinterpreted in the framework of monopole production via the thermal Schwinger process (GOULD 17); this gives rise to lower mass limits. NODE=S028C;LINKAGE=I

[26] Multiphoton events. NODE=S028C;LINKAGE=A

[27] Cherenkov radiation polarization. NODE=S028C;LINKAGE=C

[28] Re-examines CERN neutrino experiments. NODE=S028C;LINKAGE=B

Monopole Production — Other Accelerator Searches

NODE=S028A

NODE=S028A

MASS (GeV)	*CHG* (*g*)	*SPIN*	*ENERGY* (GeV)	*BEAM*	*DOCUMENT ID*		*TECN*	
> 610	≥ 1	0	1800	$p\overline{p}$	[1] ABBOTT	98K	D0	
> 870	≥ 1	1/2	1800	$p\overline{p}$	[1] ABBOTT	98K	D0	OCCUR=2
>1580	≥ 1	1	1800	$p\overline{p}$	[1] ABBOTT	98K	D0	OCCUR=3
> 510			88–94	e^+e^-	[2] ACCIARRI	95C	L3	

[1] ABBOTT 98K search for heavy pointlike Dirac monopoles via central production of a pair of photons with high transverse energies. NODE=S028A;LINKAGE=A

[2] ACCIARRI 95C finds a limit B($Z \rightarrow \gamma\gamma\gamma$) $< 0.8 \times 10^{-5}$ (which is possible via a monopole loop) at 95% CL and sets the mass limit via a cross section model. NODE=S028A;LINKAGE=D

Monopole Flux — Cosmic Ray Searches

NODE=S028F

"Caty" in the charge column indicates a search for monopole-catalyzed nucleon decay. NODE=S028F

NODE=S028F

FLUX ($cm^{-2}sr^{-1}s^{-1}$)	*MASS* (GeV)	*CHG* (*g*)	*COMMENTS* ($\beta = v/c$)	*DOCUMENT ID*		*TECN*	
<2E-19		1	0.86< β <0.995	[1] ABBASI	22	ICCB	OCCUR=4
<7E-18		1	β >0.55	[2] ALBERT	22C	ANTR	
<2E-14	>5E8		6E-4< β <5E-3	[3] ACERO	21	NOVA	
<1E-17		Caty	1E-5 < β <1E-3	[4] GAPONENKO	21	BAIK	
<1.5E−18		1	β >0.6	[5] ALBERT	17	ANTR	
<2.5E−21		1	1E8< γ <1E13	[6] AAB	16	AUGE	
<1.55E-18			β >0.51	[7] AARTSEN	16B	ICCB	
<1E-17		Caty	1E-3< β <1E-2	[8] AARTSEN	14	ICCB	
<3E-18		1	β >0.8	[9] ABBASI	13	ICCB	
<1.3E-17		1	β >0.625	[10] ADRIAN-MAR...	12A	ANTR	
<6E-28	<1E17	Caty	1E-5< β <0.04	[11] UENO	12	SKAM	
<1E-19		1	γ >1E10	[12] DETRIXHE	11	ANIT	
<3.8E-17		1	β >0.76	[9] ABBASI	10A	ICCB	
<1.3E−15	1E4<M<5E13	1	β >0.05	[13] BALESTRA	08	PLAS	
<0.65E−15	>5E13	1	β >0.05	[13] BALESTRA	08	PLAS	OCCUR=2
<1E−18		1	γ >1 E8	[12] HOGAN	08	RICE	
<1.4E−16		**1**	**1.1E−4 < β <0.99**	[14] AMBROSIO	02B	MCRO	
<3E−16		Caty	1.1E−4 < β <5E−3	[15] AMBROSIO	02C	MCRO	
<1.5E−15		1	5E−3 < β < 0.99	[16] AMBROSIO	02D	MCRO	
<1E−15		1	1.1×10^{-4}–0.1	[17] AMBROSIO	97	MCRO	
<5.6E−15		1	(0.18–3.0)E−3	[18] AHLEN	94	MCRO	
<2.7E−15		Caty	$\beta \sim 1 \times 10^{-3}$	[19] BECKER-SZ...	94	IMB	
<8.7E−15		1	>2.E−3	THRON	92	SOUD	
<4.4E−12		1	all β	GARDNER	91	INDU	
<7.2E−13		1	all β	HUBER	91	INDU	
<3.7E−15	>E12	1	β=1.E−4	[20] ORITO	91	PLAS	
<3.2E−16	>E10	1	β > 0.05	[20] ORITO	91	PLAS	OCCUR=2
<3.2E−16	>E10–E12	2, 3		[20] ORITO	91	PLAS	OCCUR=3
<3.8E−13		1	all β	BERMON	90	INDU	
<5.E−16		Caty	β <1.E−3	[19] BEZRUKOV	90	CHER	
<1.8E−14		1	β >1.1E−4	[21] BUCKLAND	90	HEPT	
<1E−18			3.E−4 < β <1.5E−3	[22] GHOSH	90	MICA	
<7.2E−13		1	all β	HUBER	90	INDU	
<5.E−12	>E7	1	3.E−4 < β <5.E−3	BARISH	87	CNTR	
<1.E−13		Caty	1.E−5 < β <1	[19] BARTELT	87	SOUD	
<1.E−10		1	all β	EBISU	87	INDU	
<2.E−13			1.E−4 < β <6.E−4	MASEK	87	HEPT	
<2.E−14			4.E−5 < β <2.E−4	NAKAMURA	87	PLAS	

<2.E−14			1.E−3 < β <1	NAKAMURA	87	PLAS	OCCUR=2
<5.E−14			9.E−4 < β <1.E−2	SHEPKO	87	CNTR	
<2.E−13			4.E−4 < β <1	TSUKAMOTO	87	CNTR	
<5.E−14		1	all β	[23] CAPLIN	86	INDU	
<5.E−12		1		CROMAR	86	INDU	
<1.E−13		1	7.E−4 < β	HARA	86	CNTR	
<7.E−11		1	all β	INCANDELA	86	INDU	
<1.E−18			4.E−4 < β <1.E−3	[22] PRICE	86	MICA	
<5.E−12		1		BERMON	85	INDU	
<6.E−12		1		CAPLIN	85	INDU	
<6.E−10		1		EBISU	85	INDU	
<3.E−15		Caty	5.E−5 ≤ β ≤ 1.E−3	[19] KAJITA	85	KAMI	
<2.E−21		Caty	β <1.E−3	[19,24] KAJITA	85	KAMI	OCCUR=2
<3.E−15		Caty	1.E−3 < β <1.E−1	[19] PARK	85B	CNTR	
<5.E−12		1	1.E−4 < β <1	BATTISTONI	84	NUSX	
<7.E−12		1		INCANDELA	84	INDU	
<7.E−13		1	3.E−4 < β	[21] KAJINO	84	CNTR	
<2.E−12		1	3.E−4 < β <1.E−1	KAJINO	84B	CNTR	
<6.E−13		1	5.E−4 < β <1	KAWAGOE	84	CNTR	
<2.E−14			1.E−3 < β	[19] KRISHNA...	84	CNTR	
<4.E−13		1	6.E−4 < β <2.E−3	LISS	84	CNTR	
<1.E−16			3.E−4 < β <1.E−3	[22] PRICE	84	MICA	
<1.E−13		1	1.E−4 < β	PRICE	84B	PLAS	
<4.E−13		1	6.E−4 < β <2.E−3	TARLE	84	CNTR	
				[25] ANDERSON	83	EMUL	
<4.E−13		1	1.E−2 < β <1.E−3	BARTELT	83B	CNTR	
<1.E−12		1	7.E−3 < β <1	BARWICK	83	PLAS	
<3.E−13		1	1.E−3 < β <4.E−1	BONARELLI	83	CNTR	
<3.E−12		Caty	5.E−4 < β <5.E−2	[19] BOSETTI	83	CNTR	
<4.E−11		1		CABRERA	83	INDU	
<5.E−15		1	1.E−2 < β <1	DOKE	83	PLAS	
<8.E−15		Caty	1.E−4 < β <1.E−1	[19] ERREDE	83	IMB	
<5.E−12		1	1.E−4 < β <3.E−2	GROOM	83	CNTR	
<2.E−12			6.E−4 < β <1	MASHIMO	83	CNTR	
<1.E−13		1	β=3.E−3	ALEXEYEV	82	CNTR	
<2.E−12		1	7.E−3 < β <6.E−1	BONARELLI	82	CNTR	
6.E−10		1	all β	[26] CABRERA	82	INDU	
<2.E−11			1.E−2 < β <1.E−1	MASHIMO	82	CNTR	
<2.E−15			concentrator	BARTLETT	81	PLAS	
<1.E−13	>1		1.E−3 < β	KINOSHITA	81B	PLAS	
<5.E−11	<E17		3.E−4 < β <1.E−3	ULLMAN	81	CNTR	
<2.E−11			concentrator	BARTLETT	78	PLAS	
1.E−1	>200	2		[27] PRICE	75	PLAS	
<2.E−13		>2		FLEISCHER	71	PLAS	
<1.E−19		>2	obsidian, mica	FLEISCHER	69C	PLAS	
<5.E−15	<15	<3	concentrator	CARITHERS	66	ELEC	
<2.E−11		<1–3	concentrator	MALKUS	51	EMUL	

[1] ABBASI 22 search was based on Cherenkov light detection in an array of optical modules in the Antarctic ice cap. Limits are speed-dependent. NODE=S028F;LINKAGE=S

[2] ALBERT 22C search for magnetic monopoles using data taken with the ANTARES neutrino telescope over a period of 10 years. No signal observed. Velocity dependent upper limits set on the flux of magnetic monopoles. NODE=S028F;LINKAGE=T

[3] ACERO 21 employ NOvA experiment to set reported 90% CL upper limit on the cosmic monopoles flux for velocity $6 \times 10^{-4} < \beta < 5 \times 10^{-3}$ and mass $> 5 \times 10^{8}$ GeV. NODE=S028F;LINKAGE=N

[4] GAPONENKO 21 use data of NT200 two-year operation at Baikal to give speed-dependent limits for different assumed catalysis cross sections. Reported limit is for $\sigma = 10$ mb. NODE=S028F;LINKAGE=O

[5] ALBERT 17 limits were estimated using a Cherenkov light in an array of optical modules under the Mediterranean Sea. The limits are for MM masses between 10^{10} and 10^{14} GeV. The limits are speed-dependent. NODE=S028F;LINKAGE=M

[6] AAB 16 search was made with a set of telescopes sampling the longitudinal profile of fluorescence light emitted by extensive air showers. Limits are speed dependent. NODE=S028F;LINKAGE=J

[7] AARTSEN 16B was based on a Cherenkov signature in an array of optical modules which were sunk in the Antarctic ice cap. Limits are speed-dependent. NODE=S028F;LINKAGE=I

[8] Beyond the monopole speed, the limits of AARTSEN 14 depend on the catalysis cross section (σ) which corresponds to the monopole radiating $\hat{l}$ times the light per track length compared to the Cherenkov light from a single electrically charged, relativistic particle. The values quoted here correspond to $\sigma = 1$ barn or $\hat{l} = 30$. NODE=S028F;LINKAGE=B

[9] ABBASI 13 and ABBASI 10A were based on a Cherenkov signature in an array of optical modules which were sunk in the Antarctic ice cap. Limits are speed-dependent. NODE=S028F;LINKAGE=AB

[10] ADRIAN-MARTINEZ 12A measurements were based on a Cherenkov signature in an underwater telescope in the Western Mediterranean Sea. Limits are speed-dependent. NODE=S028F;LINKAGE=AD

[11] The limits from UENO 12 depend on the monopole speed and are also sensitive to assumed values of monopole mass and the catalysis cross section. NODE=S028F;LINKAGE=UE

[12] HOGAN 08 and DETRIXHE 11 limits on relativistic monopoles are based on nonobservation of radio Cherenkov signals at the South Pole. Limits are speed-dependent. NODE=S028F;LINKAGE=HO

[13] BALESTRA 08 exposed of nuclear track detector modules totaling 400 m^2 for 4 years at the Chacaltaya Laboratory (5230 m) in search for intermediate-mass monopoles with $\beta >$ 0.05. The analysis is mainly based on three CR39 modules. For M $> 5 \times 10^{13}$ GeV there can be upward-going monopoles as well, hence the flux limit is half that obtained for less massive monopoles. Previous experiments (e.g. MACRO and OHYA (ORITO 91)) had set limits only for M $> 1 \times 10^9$ GeV. NODE=S028F;LINKAGE=BA

[14] AMBROSIO 02B direct search final result for $m \geq 10^{17}$ GeV, based upon 4.2 to 9.5 years of running, depending upon the subsystem. Limit with CR39 track-etch detector extends the limit from β=4 $\times$ 10^{-5} (3.1 $\times$ 10^{-16} cm^{-2} sr^{-1} s^{-1}) to β= 1 $\times$ 10^{-4} (2.1 $\times$ 10^{-16} cm^{-2} sr^{-1} s^{-1}). Limit curve in paper is piecewise continuous due to different detection techniques for different β ranges. NODE=S028F;LINKAGE=S2

[15] AMBROSIO 02C limit for catalysis of nucleon decay with catalysis cross section of $\approx$ 1 mb. The flux limit increases by $\sim$ 3 at the higher β limit, and increases to 1×10^{-14} cm^{-2} sr^{-1} s^{-1} if the catalysis cross section is 0.01 mb. Based upon 71193 hr of data with the streamer detector, with an acceptance of 4250 m^2 sr. NODE=S028F;LINKAGE=S3

[16] AMBROSIO 02D result for "more than two years of data." Ionization search using several subsystems. Limit curve as a function of β not given. Included in AMBROSIO 02B. NODE=S028F;LINKAGE=S1

[17] AMBROSIO 97 global MACRO 90%CL is 0.78×10^{-15} at β=1.1×10^{-4}, goes through a minimum at 0.61 $\times$ 10^{-15} near β=(1.1–2.7) $\times$ 10^{-3}, then rises to 0.84 $\times$ 10^{-15} at β=0.1. The global limit in this region is below the Parker bound at 10^{-15}. Less stringent limits are established for 4 $\times$ 10^{-5} $< \beta <$ 1 $\times$ 10^{-4}. Limits set by various triggers and different subdetectors are given in the paper. All limits assume a catalysis cross section smaller than a few mb. NODE=S028F;LINKAGE=A7

[18] AHLEN 94 limit for dyons extends down to β=0.9E$-$4 and a limit of 1.3E$-$14 extends to β = 0.8E$-$4. Also see comment by PRICE 94 and reply of BARISH 94. One loophole in the AHLEN 94 result is that in the case of monopoles catalyzing nucleon decay, relativistic particles could veto the events. See AMBROSIO 97 for additional results. NODE=S028F;LINKAGE=H

[19] Catalysis of nucleon decay; sensitive to assumed catalysis cross section. NODE=S028F;LINKAGE=C

[20] ORITO 91 limits are functions of velocity. Lowest limits are given here. NODE=S028F;LINKAGE=Q1

[21] Used DKMPR mechanism and Penning effect. NODE=S028F;LINKAGE=F

[22] Assumes monopole attaches fermion nucleus. NODE=S028F;LINKAGE=E

[23] Limit from combining data of CAPLIN 86, BERMON 85, INCANDELA 84, and CABRERA 83. For a discussion of controversy about CAPLIN 86 observed event, see GUY 87. Also see SCHOUTEN 87. NODE=S028F;LINKAGE=G

[24] Based on lack of high- energy solar neutrinos from catalysis in the sun. NODE=S028F;LINKAGE=K

[25] Anomalous long-range α (^{4}He) tracks. NODE=S028F;LINKAGE=D

[26] CABRERA 82 candidate event has single Dirac charge within $\pm$5%. NODE=S028F;LINKAGE=Q

[27] ALVAREZ 75, FLEISCHER 75, and FRIEDLANDER 75 explain as fragmenting nucleus. EBERHARD 75 and ROSS 76 discuss conflict with other experiments. HAGSTROM 77 reinterprets as antinucleus. PRICE 78 reassesses. NODE=S028F;LINKAGE=A

Monopole Flux — Astrophysics

NODE=S028FA
NODE=S028FA

FLUX (cm^{-2}sr^{-1}s^{-1})	*MASS* (GeV)	*CHG* (*g*)	*COMMENTS* (β = *v*/*c*)	*DOCUMENT ID*		*TECN*
$< 3 \times 10^{-21}$	$< 10^{18}$	1	Parker	[1] KOBAYASHI	23A	COSM
$< 1.3 \times 10^{-20}$			faint white dwarf	[2] FREESE	99	ASTR
$< 1 \times 10^{-16}$	10^{17}	1	galactic field	[3] ADAMS	93	COSM
$< 1 \times 10^{-23}$			Jovian planets	[2] ARAFUNE	85	ASTR
$< 1 \times 10^{-16}$	10^{15}		solar trapping	BRACCI	85B	ASTR
$< 1 \times 10^{-18}$		1		[2] HARVEY	84	COSM
$< 3 \times 10^{-23}$			neutron stars	KOLB	84	ASTR
$< 7 \times 10^{-22}$			pulsars	[2] FREESE	83B	ASTR
$< 1 \times 10^{-18}$	$< 10^{18}$	1	intergalactic field	[2] REPHAELI	83	COSM
$< 1 \times 10^{-23}$			neutron stars	[2] DIMOPOUL...	82	COSM
$< 5 \times 10^{-22}$			neutron stars	[2] KOLB	82	COSM
$< 5 \times 10^{-15}$	$> 10^{21}$		galactic halo	SALPETER	82	COSM
$< 1 \times 10^{-12}$	10^{19}	1	β=3 $\times$ 10^{-3}	[4] TURNER	82	COSM
$< 1 \times 10^{-16}$		1	galactic field	PARKER	70	COSM

[1] KOBAYASHI 23A found Parker-type bounds on magnetic monopoles with arbitrary magnetic charge based on the survival of galactic, seed, and primordial magnetic fields. Bounds are between 3×10^{-21} and 10^{-5} cm^{-2}sr^{-1}s^{-1} for masses $< 10^{18}$ GeV. Reported bound is the most stringent one. NODE=S028FA;LINKAGE=Q

[2] Catalysis of nucleon decay. NODE=S028FA;LINKAGE=C

[3] ADAMS 93 limit based on "survival and growth of a small galactic seed field" is 10^{-16} ($m/10^{17}$ GeV) cm^{-2} s^{-1} sr^{-1}. Above 10^{17} GeV, limit 10^{-16} (10^{17} GeV$/m$) cm^{-2} s^{-1} sr^{-1} (from requirement that monopole density does not overclose the universe) is more stringent. NODE=S028FA;LINKAGE=A

[4] Re-evaluates PARKER 70 limit for GUT monopoles. NODE=S028FA;LINKAGE=B

Monopole Density — Matter Searches

NODE=S028D
NODE=S028D

DENSITY	CHG (g)	MATERIAL	DOCUMENT ID		TECN	
<9.8E−5/gram	≥ 1	Polar rock	BENDTZ	13	INDU	
<6.9E−6/gram	>1/3	Meteorites and other	JEON	95	INDU	
<2.E−7/gram	>0.6	Fe ore	[1] EBISU	87	INDU	
<4.6E−6/gram	> 0.5	deep schist	KOVALIK	86	INDU	
<1.6E−6/gram	> 0.5	manganese nodules	[2] KOVALIK	86	INDU	OCCUR=2
<1.3E−6/gram	> 0.5	seawater	KOVALIK	86	INDU	OCCUR=3
>1.E+14/gram	>1/3	iron aerosols	MIKHAILOV	83	SPEC	
<6.E−4/gram		air, seawater	CARRIGAN	76	CNTR	
<5.E−1/gram	>0.04	11 materials	CABRERA	75	INDU	
<2.E−4/gram	>0.05	moon rock	ROSS	73	INDU	
<6.E−7/gram	<140	seawater	KOLM	71	CNTR	
<1.E−2/gram	<120	manganese nodules	FLEISCHER	69	PLAS	
<1.E−4/gram	>0	manganese	FLEISCHER	69B	PLAS	
<2.E−3/gram	<1–3	magnetite, meteor	GOTO	63	EMUL	
<2.E−2/gram		meteorite	PETUKHOV	63	CNTR	

[1] Mass 1×10^{14}–1×10^{17} GeV. NODE=S028D;LINKAGE=E

[2] KOVALIK 86 examined 498 kg of schist from two sites which exhibited clear mineralogical evidence of having been buried at least 20 km deep and held below the Curie temperature. NODE=S028D;LINKAGE=A

Monopole Density — Astrophysics

NODE=S028DA
NODE=S028DA

DENSITY	CHG (g)	MATERIAL	DOCUMENT ID		TECN
<1.E−9/gram	1	sun, catalysis	[1] ARAFUNE	83	COSM
<6.E−33/nucl	1	moon wake	SCHATTEN	83	ELEC
<2.E−28/nucl		earth heat	CARRIGAN	80	COSM
<2.E−4/prot		42cm absorption	BRODERICK	79	COSM
<2.E−13/m^3		moon wake	SCHATTEN	70	ELEC

[1] Catalysis of nucleon decay. NODE=S028DA;LINKAGE=C

REFERENCES FOR Magnetic Monopole Searches

NODE=S028

AAD	25B	PRL 134 061803	G. Aad *et al.*	(ATLAS Collab.)	REFID=63307
ACHARYA	25	PRL 134 071802	B. Acharya *et al.*	(MoEDAL Collab.)	REFID=63310
ACHARYA	24	PRL 133 071803	B. Acharya *et al.*	(MoEDAL Collab.)	REFID=62696
AAD	23CO	JHEP 2311 112	G. Aad *et al.*	(ATLAS Collab.)	REFID=62609
KOBAYASHI	23A	PR D108 083005	T. Kobayashi, D. Perri	(SISSA)	REFID=62497
ABBASI	22	PRL 128 051101	R. Abbasi *et al.*	(IceCube Collab.)	REFID=61615
ACHARYA	22A	EPJ C82 694	B. Acharya *et al.*	(MoEDAL Collab.)	REFID=61836
ACHARYA	22B	NAT 602 63	B. Acharya *et al.*	(MoEDAL Collab.)	REFID=61847
ALBERT	22C	JHEAP 34 1	A. Albert *et al.*	(ANTARES Collab.)	REFID=63233
ACERO	21	PR D103 012007	M.A. Acero *et al.*	(NOvA Collab.)	REFID=60819
ACHARYA	21	PRL 126 071801	B. Acharya *et al.*	(MoEDAL Collab.)	REFID=61163
GAPONENKO	21	PAN 84 287	O.N. Gaponenko	(ASCI)	REFID=61344
AAD	20G	PRL 124 031802	G. Add *et al.*	(ATLAS Collab.)	REFID=60214
ACHARYA	19B	PRL 123 021802	B. Acharya *et al.*	(MoEDAL Collab.)	REFID=59799
ACHARYA	18A	PL B782 510	B. Acharya *et al.*	(MoEDAL Collab.)	REFID=59027
ACHARYA	17	PRL 118 061801	B. Acharya *et al.*	(MoEDAL Collab.)	REFID=57756
ALBERT	17	JHEP 1707 054	A. Albert *et al.*	(ANTARES Collab.)	REFID=57823
GOULD	17	PRL 119 241601	O. Gould, A. Rajantie		REFID=58282
AAB	16	PR D94 082002	A. Aab *et al.*	(Pierre Auger Collab.)	REFID=57531
AAD	16AB	PR D93 052009	G. Aad *et al.*	(ATLAS Collab.)	REFID=57267
AARTSEN	16B	EPJ C76 133	M.G. Aartsen *et al.*	(IceCube Collab.)	REFID=57366
ACHARYA	16	JHEP 1608 067	B. Acharya *et al.*	(MoEDAL Collab.)	REFID=57345
AARTSEN	14	EPJ C74 2938	M.G. Aartsen *et al.*	(IceCube Collab.)	REFID=55700
Also		EPJ C79 124 (errat.)	M.G. Aartsen *et al.*	(IceCube Collab.)	REFID=59707
ABBASI	13	PR D87 022001	R. Abbasi *et al.*	(IceCube Collab.)	REFID=55123
BENDTZ	13	PRL 110 121803	K. Bendtz *et al.*		REFID=55199
AAD	12CS	PRL 109 261803	G. Aad *et al.*	(ATLAS Collab.)	REFID=54782
ADRIAN-MAR...	12A	ASP 35 634	S. Adrian-Martinez *et al.*	(ANTARES Collab.)	REFID=54435
UENO	12	ASP 36 131	K. Ueno *et al.*	(Super-Kamiokande Collab.)	REFID=54437
DETRIXHE	11	PR D83 023513	M. Detrixhe *et al.*	(ANITA Collab.)	REFID=53727
ABBASI	10A	EPJ C69 361	R. Abbasi *et al.*	(IceCube Collab.)	REFID=53445
ABBIENDI	08	PL B663 37	G. Abbiendi *et al.*	(OPAL Collab.)	REFID=52455
BALESTRA	08	EPJ C55 57	S. Balestra *et al.*	(SLIM Collab.)	REFID=52488
HOGAN	08	PR D78 075031	D.P. Hogan *et al.*	(KANS, NEBR, DELA)	REFID=52557

ABULENCIA	06K	PRL 96 201801	A. Abulencia *et al.*	(CDF Collab.)	REFID=51230
AKTAS	05A	EPJ C41 133	A. Aktas *et al.*	(H1 Collab.)	REFID=50646
KALBFLEISCH	04	PR D69 052002	G.R. Kalbfleisch *et al.*	(OKLA)	REFID=49730
AMBROSIO	02B	EPJ C25 511	M. Ambrosio *et al.*	(MACRO Collab.)	REFID=49099
AMBROSIO	02C	EPJ C26 163	M. Ambrosio *et al.*	(MACRO Collab.)	REFID=49159
AMBROSIO	02D	ASP 18 27	M. Ambrosio *et al.*	(MACRO Collab.)	REFID=49045
KALBFLEISCH	00	PRL 85 5292	G.R. Kalbfleisch *et al.*		REFID=47881
FREESE	99	PR D59 063007	K. Freese, E. Krasteva		REFID=46986
ABBOTT	98K	PRL 81 524	B. Abbott *et al.*	(D0 Collab.)	REFID=46093
AMBROSIO	97	PL B406 249	M. Ambrosio *et al.*	(MACRO Collab.)	REFID=45553
HE	97	PRL 79 3134	Y.D. He	(UCB)	REFID=45626
ACCIARRI	95C	PL B345 609	M. Acciarri *et al.*	(L3 Collab.)	REFID=44132
JEON	95	PRL 75 1443	H. Jeon, M.J. Longo	(MICH)	REFID=44402
Also		PRL 76 159 (errat.)	H. Jeon, M.J. Longo		REFID=44751
AHLEN	94	PRL 72 608	S.P. Ahlen *et al.*	(MACRO Collab.)	REFID=43755
BARISH	94	PRL 73 1306	B.C. Barish, G. Giacomelli, J.T. Hong	(CIT+)	REFID=43991
BECKER-SZ...	94	PR D49 2169	R.A. Becker-Szendy *et al.*	(IMB Collab.)	REFID=43853
PRICE	94	PRL 73 1305	P.B. Price	(UCB)	REFID=43990
ADAMS	93	PRL 70 2511	F.C. Adams *et al.*	(MICH, FNAL)	REFID=43260
PINFOLD	93	PL B316 407	J.L. Pinfold *et al.*	(ALBE, HARV, MONT+)	REFID=43539
KINOSHITA	92	PR D46 881	K. Kinoshita *et al.*	(HARV, BGNA, REHO)	REFID=42130
THRON	92	PR D46 4846	J.L. Thron *et al.*	(SOUDAN-2 Collab.)	REFID=43115
GARDNER	91	PR D44 622	R.D. Gardner *et al.*	(STAN)	REFID=41557
HUBER	91	PR D44 636	M.E. Huber *et al.*	(STAN)	REFID=41558
ORITO	91	PRL 66 1951	S. Orito *et al.*	(ICEPP, WASCR, NIHO, ICRR)	REFID=41478
BERMON	90	PRL 64 839	S. Bermon *et al.*	(IBM, BNL)	REFID=41028
BERTANI	90	EPL 12 613	M. Bertani *et al.*	(BGNA, INFN)	REFID=41235
BEZRUKOV	90	SJNP 52 54	L.B. Bezrukov *et al.*	(INRM)	REFID=41433
		Translated from YAF 52 86.			
BUCKLAND	90	PR D41 2726	K.N. Buckland *et al.*	(UCSD)	REFID=41252
GHOSH	90	EPL 12 25	D.C. Ghosh, S. Chatterjea	(JADA)	REFID=41234
HUBER	90	PRL 64 835	M.E. Huber *et al.*	(STAN)	REFID=41029
PRICE	90	PRL 65 149	P.B. Price, J. Guiru, K. Kinoshita	(UCB, HARV)	REFID=41190
KINOSHITA	89	PL B228 543	K. Kinoshita *et al.*	(HARV, TISA, KEK+)	REFID=40828
BRAUNSCH...	88B	ZPHY C38 543	R. Braunschweig *et al.*	(TASSO Collab.)	REFID=40695
KINOSHITA	88	PRL 60 1610	K. Kinoshita *et al.*	(HARV, TISA, KEK+)	REFID=40600
BARISH	87	PR D36 2641	B.C. Barish, G. Liu, C. Lane	(CIT)	REFID=40495
BARTELT	87	PR D36 1990	J.E. Bartelt *et al.*	(Soudan Collab.)	REFID=40487
Also		PR D40 1701 (errat.)	J.E. Bartelt *et al.*	(Soudan Collab.)	REFID=40850
EBISU	87	PR D36 3359	T. Ebisu, T. Watanabe	(KOBE)	REFID=40498
Also		JP G11 883	T. Ebisu, T. Watanabe	(KOBE)	REFID=12352
GENTILE	87	PR D35 1081	T. Gentile *et al.*	(CLEO Collab.)	REFID=40489
GUY	87	NAT 325 463	J. Guy	(LOIC)	REFID=40497
MASEK	87	PR D35 2758	G.E. Masek *et al.*	(UCSD)	REFID=40494
NAKAMURA	87	PL B183 395	S. Nakamura *et al.*	(INUS, WASCR, NIHO)	REFID=40491
PRICE	87	PRL 59 2523	P.B. Price, R. Guoxiao, K. Kinoshita	(UCB, HARV)	REFID=40488
SCHOUTEN	87	JP E20 850	J.C. Schouten *et al.*	(LOIC)	REFID=40496
SHEPKO	87	PR D35 2917	M.J. Shepko *et al.*	(TAMU)	REFID=40493
TSUKAMOTO	87	EPL 3 39	T. Tsukamoto *et al.*	(ICRR)	REFID=40492
CAPLIN	86	NAT 321 402	A.D. Caplin *et al.*	(LOIC)	REFID=12343
Also		JP E20 850	J.C. Schouten *et al.*	(LOIC)	REFID=40496
Also		NAT 325 463	J. Guy	(LOIC)	REFID=40497
CROMAR	86	PRL 56 2561	M.W. Cromar, A.F. Clark, F.R. Fickett	(NBSB)	REFID=12344
HARA	86	PRL 56 553	T. Hara *et al.*	(ICRR, KYOT, KEK, KOBE+)	REFID=12345
INCANDELA	86	PR D34 2637	J. Incandela *et al.*	(CHIC, FNAL, MICH)	REFID=40490
KOVALIK	86	PR A33 1183	J.M. Kovalik, J.L. Kirschvink	(CIT)	REFID=45970
PRICE	86	PRL 56 1226	P.B. Price, M.H. Salamon	(UCB)	REFID=12346
ARAFUNE	85	PR D32 2586	J. Arafune, M. Fukugita, S. Yanagita	(ICRR, KYOTU+)	REFID=12347
BERMON	85	PRL 55 1850	S. Bermon *et al.*	(IBM)	REFID=12348
BRACCI	85B	NP B258 726	L. Bracci, G. Fiorentini, G. Mezzorani	(PISA+)	REFID=12349
Also		LNC 42 123	L. Bracci, G. Fiorentini	(PISA)	REFID=12350
CAPLIN	85	NAT 317 234	A.D. Caplin *et al.*	(LOIC)	REFID=12351
EBISU	85	JP G11 883	T. Ebisu, T. Watanabe	(KOBE)	REFID=12352
KAJITA	85	JPSJ 54 4065	T. Kajita *et al.*	(ICRR, KEK, NIIG)	REFID=40191
PARK	85B	NP B252 261	H.S. Park *et al.*	(IMB Collab.)	REFID=11717
BATTISTONI	84	PL 133B 454	G. Battistoni *et al.*	(NUSEX Collab.)	REFID=11714
FRYBERGER	84	PR D29 1524	D. Fryberger *et al.*	(SLAC, UCB)	REFID=12354
HARVEY	84	NP B236 255	J.A. Harvey	(PRIN)	REFID=12355
INCANDELA	84	PRL 53 2067	J. Incandela *et al.*	(CHIC, FNAL, MICH)	REFID=12356
KAJINO	84	PRL 52 1373	F. Kajino *et al.*	(ICRR)	REFID=12357
KAJINO	84B	JP G10 447	F. Kajino *et al.*	(ICRR)	REFID=12358
KAWAGOE	84	LNC 41 315	K. Kawagoe *et al.*	(TOKY)	REFID=12359
KOLB	84	APJ 286 702	E.W. Kolb, M.S. Turner	(FNAL, CHIC)	REFID=40192
KRISHNA...	84	PL 142B 99	M.R. Krishnaswamy *et al.*	(TATA, OSKC+)	REFID=12360
LISS	84	PR D30 884	T.M. Liss, S.P. Ahlen, G. Tarle	(UCB, IND+)	REFID=12361
PRICE	84	PRL 52 1265	P.B. Price *et al.*	(ROMA, UCB, IND+)	REFID=12362
PRICE	84B	PL 140B 112	P.B. Price	(CERN)	REFID=12363
TARLE	84	PRL 52 90	G. Tarle, S.P. Ahlen, T.M. Liss	(UCB, MICH+)	REFID=12364
ANDERSON	83	PR D28 2308	S.N. Anderson *et al.*	(WASH)	REFID=12365
ARAFUNE	83	PL 133B 380	J. Arafune, M. Fukugita	(ICRR, KYOTU)	REFID=12366
AUBERT	83B	PL 120B 465	B. Aubert *et al.*	(CERN, LAPP)	REFID=12367
BARTELT	83B	PRL 50 655	J.E. Bartelt *et al.*	(MINN, ANL)	REFID=12369
BARWICK	83	PR D28 2338	S.W. Barwick, K. Kinoshita, P.B. Price	(UCB)	REFID=12368
BONARELLI	83	PL 126B 137	R. Bonarelli, P. Capiluppi, I. d'Antone	(BGNA)	REFID=12371
BOSETTI	83	PL 133B 265	P.C. Bosetti *et al.*	(AACH3, HAWA, TOKY)	REFID=12372
CABRERA	83	PRL 51 1933	B. Cabrera *et al.*	(STAN)	REFID=12373
DOKE	83	PL 129B 370	T. Doke *et al.*	(WASU, RIKK, TTAM, RIKEN)	REFID=12374
ERREDE	83	PRL 51 245	S.M. Errede *et al.*	(IMB Collab.)	REFID=12375
FREESE	83B	PRL 51 1625	K. Freese, M.S. Turner, D.N. Schramm	(CHIC)	REFID=12376
GROOM	83	PRL 50 573	D.E. Groom *et al.*	(UTAH, STAN)	REFID=12377
MASHIMO	83	PL 128B 327	T. Mashimo *et al.*	(ICEPP)	REFID=12223
MIKHAILOV	83	PL 130B 331	V.F. Mikhailov	(KAZA)	REFID=12379

MUSSET	83	PL 128B 333	P. Musset, M. Price, E. Lohrmann	(CERN, HAMB)	REFID=12380
REPHAELI	83	PL 121B 115	Y. Rephaeli, M.S. Turner	(CHIC)	REFID=12381
SCHATTEN	83	PR D27 1525	K.H. Schatten	(NASA)	REFID=12382
ALEXEYEV	82	LNC 35 413	E.N. Alekseev *et al.*	(INRM)	REFID=12383
BONARELLI	82	PL 112B 100	R. Bonarelli *et al.*	(BGNA)	REFID=12384
CABRERA	82	PRL 48 1378	B. Cabrera	(STAN)	REFID=12385
DELL	82	NP B209 45	G.F. Dell *et al.*	(BNL, ADEL, ROMA)	REFID=12387
DIMOPOUL...	82	PL 119B 320	S. Dimopoulos, J. Preskill, F. Wilczek	(HARV+)	REFID=12386
KINOSHITA	82	PRL 48 77	K. Kinoshita, P.B. Price, D. Fryberger	(UCB+)	REFID=12388
KOLB	82	PRL 49 1373	E.W. Kolb, S.A. Colgate, J.A. Harvey	(LASL, PRIN)	REFID=12389
MASHIMO	82	JPSJ 51 3067	T. Mashimo, K. Kawagoe, M. Koshiba	(INUS)	REFID=12228
SALPETER	82	PRL 49 1114	E.E. Salpeter, S.L. Shapiro, I. Wasserman	(CORN)	REFID=40193
TURNER	82	PR D26 1296	M.S. Turner, E.N. Parker, T.J. Bogdan	(CHIC)	REFID=12391
BARTLETT	81	PR D24 612	D.F. Bartlett *et al.*	(COLO, GESC)	REFID=12392
KINOSHITA	81B	PR D24 1707	K. Kinoshita, P.B. Price	(UCB)	REFID=12394
ULLMAN	81	PRL 47 289	J.D. Ullman	(LEHM, BNL)	REFID=12395
CARRIGAN	80	NAT 288 348	R.A. Carrigan	(FNAL)	REFID=12396
BRODERICK	79	PR D19 1046	J.J. Broderick *et al.*	(VPI)	REFID=12397
BARTLETT	78	PR D18 2253	D.F. Bartlett, D. Soo, M.G. White	(COLO, PRIN)	REFID=12398
CARRIGAN	78	PR D17 1754	R.A. Carrigan, B.P. Strauss, G. Giacomelli	(FNAL+)	REFID=12399
HOFFMANN	78	LNC 23 357	H. Hoffmann *et al.*	(CERN, ROMA)	REFID=12400
PRICE	78	PR D18 1382	P.B. Price *et al.*	(UCB, HOUS)	REFID=12401
HAGSTROM	77	PRL 38 729	R. Hagstrom	(LBL)	REFID=12402
CARRIGAN	76	PR D13 1823	R.A. Carrigan, F.A. Nezrick, B.P. Strauss	(FNAL)	REFID=12403
DELL	76	LNC 15 269	G.F. Dell *et al.*	(CERN, BNL, ROMA, ADEL)	REFID=12404
ROSS	76	LBL-4665	R.R. Ross	(LBL)	REFID=12405
STEVENS	76B	PR D14 2207	D.M. Stevens *et al.*	(VPI, BNL)	REFID=12406
ZRELOV	76	CZJP B26 1306	V.P. Zrelov *et al.*	(JINR)	REFID=12407
ALVAREZ	75	LBL-4260	L.W. Alvarez	(LBL)	REFID=12408
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Also		PR D3 56	R.A. Carrigan, F.A. Nezrick	(FNAL)	REFID=12412
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EBERHARD	75B	LBL-4289	P.H. Eberhard	(LBL)	REFID=12413
FLEISCHER	75	PRL 35 1412	R.L. Fleischer, R.N.F. Walker	(GESC, WUSL)	REFID=12415
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GIACOMELLI	75	NC 28A 21	G. Giacomelli *et al.*	(BGNA, CERN, SACL+)	REFID=12417
PRICE	75	PRL 35 487	P.B. Price *et al.*	(UCB, HOUS)	REFID=12418
CARRIGAN	74	PR D10 3867	R.A. Carrigan, F.A. Nezrick, B.P. Strauss	(FNAL)	REFID=12419
CARRIGAN	73	PR D8 3717	R.A. Carrigan, F.A. Nezrick, B.P. Strauss	(FNAL)	REFID=12420
ROSS	73	PR D8 698	R.R. Ross *et al.*	(LBL, SLAC)	REFID=12421
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FLEISCHER	69B	PR 184 1393	R.L. Fleischer *et al.*	(GESC, UNCS, GSCO)	REFID=12433
FLEISCHER	69C	PR 184 1398	R.L. Fleischer, P.B. Price, R.T. Woods	(GESC)	REFID=12434
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