MILEY 90 PRL 65 3092 +Avignone, Brodzinski, Collar, Reeves (SCUC, PNL)
STAUDT 90 EPL 13 31 +Muto, Klapdor-Kleingrothaus (MPIH)
VASENKO 90 MPL A5 1299 +Kirpichnikov, Kuznetsov, Starostin (ITEP, YERE)
VIDYAKIN 90 JETP 71 424 +Vyrodov, Gurevich, Koslov+ (KIAE)
Translated from ZETF 98 764.
ABRAMS 89C PRL 63 2447 +Adolphsen, Averill, Ballam+ (Mark II Collab.)
AGLIETTA 89 EPL 8 611 +Battistoni, Bellotti+ (FREJUS Collab.)
ALSTON-... 89 PRL 63 1671 Alston-Garnjost, Dougherty+ (LBL, MTHO, UNM, INEL)
ASTIER 89 PL B220 646 +Bernardi, Carugno+ (CURIN, PARIN, BOST, CERN, BNL)
BAHCALL 89 Neutrino Astrophysics, Cambridge Univ. Press (IAS)
BAHCALL 89B PR D40 931 +Haxton (IAS, WASH)
BARABASH 89 PL B223 273 +Kuzminov, Lobashev, Novikov+ (ITEP, INRM)
BELLOTTI 89 PL B221 209 +Cremonesi, Fiorini, Gervasio+ (MILA)
BLUMENFELD 89 PRL 62 2237 +Chi, Chichura, Chien+ (COLU, ILL, JHU)
DANEVICH 89 JETPL 49 476 +Zdesenko, Nikolaiko, Tretyak (UZINR)
Translated from ZETFP 49 417.
DAVIS 89 ARNPS 39 467 +Mann, Wolfenstein (BNL, PENN, CMU)
DRUKAREV 89 SJNP 50 184 +Strikman (PNPI)
Translated from YAF 50 294.
FISHER 89 PL B218 257 +Boehm, Bovet, Egger+ (CIT, NEUC, PSI)
HIME 89 PR D39 1837 +Simpson (GUEL)
LOGAN 89 NIM A280 167 (OTTA)
MUTO 89 ZPHY A334 187 +Bender, Klapdor (TINT, MPIH)
OYAMA 89 PR D39 1481 +Hirata, Kajita, Kifune+ (Kamiokande II Collab.)
SIMPSON 89 PR D39 1825 +Hime (GUEL)
AFONIN 88 JETP 67 213 +Ketov, Kopeikin, Mikaelyan+ (KIAE)
Translated from ZETF 94 1.
AKERLOF 88 PR D37 577 +Chapman, Errede, Ken+ (HRS Collab.)
AMMOSOV 88 ZPHY C40 487 +Belikov+ (SKAT Collab.)
BAHCALL 88 RMP 60 297 +Ulrich (IAS, UCLA)
BERGSMA 88 ZPHY C40 171 +Dorenbosch, Nieuwenhuis+ (CHARM Collab.)
BERNARDI 88 PL B203 332 +Carugno, Chauveau+ (PARIN, CERN, INFN, ATEN)
BIONTA 88 PR D38 768 +Blewitt, Bratton, Casper+ (IMB Collab.)
DURKIN 88 PRL 61 1811 +Harper, Ling+ (OSU, ANL, CIT, LBL, LSU, LANL)
ENGEL 88 PR C37 731 +Vogel, Zimbene
HIRATA 88 PL B205 416 +Kajita, Koshiba+ (Kamiokande II Collab.)
LOVERRE 88 PL B206 711 (INFN)
MORALES 88 NC 100A 525 +Morales, Nunez-Lagos, Puimedon+ (ZARA)
TURCK-CHI... 88 APJ 335 415 Turck-Chieze, Cahen, Casse, Doom (SACL, BRUX)
ZLIMEN 88 PS 38 539 +Kaucic, Ljubicic, Logan (BOSK, CARL)
AFONIN 87 JETPL 45 257 +Bogatov, Vershinskii+ (KIAE)
Translated from ZETFP 45 201.
AHRENS 87 PR D36 702 + (BNL, BROW, UCI, HIRO, KEK, OSAK, PENN, STON)
BELLOTTI 87 EPL 3 889 +Cattadori, Cremonesi, Fiorini+ (MILA)
BOEHM 87 Massive Neutrinos +Vogel (CIT)
Cambridge Univ. Press, Cambridge
BOFILL 87 PR D36 3309 +Busza, Eldridge+ (MIT, FNAL, MSU)
CALDWELL 87 PRL 59 419 +Eisberg, Grumm, Witherell+ (UCSB, LBL)
DAUM 87 PR D36 2624 +Kettle, Jost+ (SIN, VIRG)
ELLIOTT 87B PRL 59 2020 +Hahn, Moe (UCI)
HETHERING... 87 PR C36 1504 Hetherington, Graham+ (CRNL)
LOSECCO 87 PL B184 305 +Bionta, Blewitt, Bratton+ (IMB Collab.)
MISHRA 87 PRL 59 1397 +Auchincloss+ (COLU, CIT, FNAL, CHIC, ROCH)
OBERAUER 87 PL B198 113 +von Feilitzsch, Mossbauer (MUNT)
TALEBZADEH 87 NP B291 503 +Guy, Venus+ (BEBC WA66 Collab.)
TOMODA 87 PL B199 475 +Faessler (TUBIN)
VIDYAKIN 87 JETP 66 243 +Vyrodov, Gurevich, Kozlov+ (KIAE)
Translated from ZETF 93 424.
WENDT 87 PRL 58 1810 +Abrams, Amidei, Baden+ (Mark II Collab.)
AFONIN 86 JETPL 44 142 +Bogatov, Borovoi, Vershinskii+ (KIAE)
Translated from ZETFP 44 111.
ANGELINI 86 PL B179 307 +Apostolakis, Baldini+ (PISA, ATHU, PADO, WISC)
AZUELOS 86 PRL 56 2241 +Britton, Bryman+ (TRIU, CNRC)
BADIER 86 ZPHY C31 21 +Bemporad, Boucrot, Callot+ (NA3 Collab.)
BELLOTTI 86 NC 95A 1 +Cremonesi, Fiorini, Liguori+ (MILA)
BERNARDI 86 PL 166B 479 +Carugno+ (CURIN, INFN, CDEF, ATEN, CERN)
BERNARDI 86B PL B181 173 +Carugno+ (CURIN, INFN, CDEF, ATEN, CERN)
BORGE 86 PS 34 591 +DeRujula, Hansen, Jonson+ (ISOLDE Collab.)
BRUCKER 86 PR D34 2183 +Jacques, Kalelkar, Koller+ (RUTG, BNL, COLU)
CALDWELL 86 PR D33 2737 +Eisberg, Grumm, Hale, Witherell+ (UCSB, LBL)
DELEENER-... 86 PL B177 228 DeLeener-Rosier, Deutsch+ (LVLN, ZURI, LAUS)
DORENBOS... 86 PL 166B 473 Dorenbosch, Allaby, Amaldi+ (CHARM Collab.)
DRUKAREV 86 JETP 64 686 +Strikman (PNPI)
Translated from ZETF 91 1160.
ELLIOTT 86 PRL 56 2582 +Hahn, Moe (UCI)
EMAN 86 PR C33 2128 +Tadic (BOSK)
GROTZ 86 NC C9 535 +Klapdor (MPIH)
LINDHARD 86 PRL 57 965 +Hansen (AARH)
SIMPSON 86 PL B174 113 (GUEL)
USHIDA 86C PRL 57 2897 +Kondo, Tasaka, Park, Song+ (FNAL E531 Collab.)
ZACEK 86 PR D34 2621 +Feilitzsch+ (CIT-SIN-TUM Collab.)
AFONIN 85 JETPL 41 435 +Borovoi, Dobrynin+ (KIAE)
Translated from ZETFP 41 355.
Also 85B JETPL 42 285 Afonin, Bogatov, Borovoi, Dobrynin+ (KIAE)
Translated from ZETFP 42 230.
AHRENS 85 PR D31 2732 +Aronson+ (BNL, BROW, KEK, OSAK, PENN+)
ALBRECHT 85I PL 163B 404 +Binder, Drescher, Schubert+ (ARGUS Collab.)
ALTZITZOG... 85 PRL 55 799 Altzitzoglou, Calaprice, Dewey+ (PRIN)
APALIKOV 85 JETPL 42 289 +Boris, Golutvin, Laptin, Lubimov+ (ITEP)
Translated from ZETFP 42 233.
BELIKOV 85 SJNP 41 589 +Volkov, Kochetkov, Mukhin+ (SERP)
Translated from YAF 41 919.
CALDWELL 85 PRL 54 281 +Eisberg, Grumm, Hale, Witherell+ (UCSB, LBL)
COOPER-... 85 PL 160B 207 Cooper-Sarkar+ (CERN, LOIC, OXF, SACL+)
DATAR 85 Nature 318 547 +Baba, Bhattacherjee, Bhuinya, Roy (BHAB, TATA)
HAXTON 85 PRL 55 807 (WASH, LASL)
HUBERT 85 NC 85A 19 +Leccia, Dassie, Mennrath+ (BCEN, ZARA)
KALBFLEISCH 85 PRL 55 2225 +Milton (OKLA)
MARKEY 85 PR C32 2215 +Boehm (CIT)
OHI 85 PL 160B 322 +Nakajima, Tamura+ (TOKY, INUS, KEK)
SIMPSON 85 PRL 54 1891 (GUEL)
STOCKDALE 85 ZPHY C27 53 +Bodek+ (ROCH, CHIC, COLU, FNAL)
ZACEK 85 PL 164B 193 +Zacek, Boehm+ (MUNI, CIT, SIN)
BALLAGH 84 PR D30 2271 +Bingham+ (UCB, LBL, FNAL, HAWA, WASH, WISC)
BELLOTTI 84 PL 146B 450 +Cremonesi, Fiorini, Liguori, Pullia+ (MILA)
BERGSMA 84 PL 142B 103 +Dorenbosch, Allaby, Abt+ (CHARM Collab.)
CAVAIGNAC 84 PL 148B 387 +Hoummada, Koang+ (ISNG, LAPP)
DYDAK 84 PL 134B 281 +Feldman+ (CERN, DORT, HEIDH, SACL, WARS)
FORSTER 84 PL 138B 301 +Kwon, Markey, Boehm, Henrikson (CIT)
GABATHULER 84 PL 138B 449 +Boehm+ (CIT, SIN, MUNI)
HAXTON 84 PPNP 12 409 +Stevenson
MINEHART 84 PRL 52 804 +Ziock, Marshall, Stephens, Daum+ (VIRG, SIN)
STOCKDALE 84 PRL 52 1384 +Bodek+ (ROCH, CHIC, COLU, FNAL)
AFONIN 83 JETPL 38 436 +Bogatov, Borovoi, Vershinskii+ (KIAE)
Translated from ZETFP 38 361.
AVIGNONE 83 PRL 50 721 +Brodzinski, Brown, Evans, Hensley+ (SCUC, PNL)
BELENKII 83 JETPL 38 493 +Dobrynin, Zemlyakov, Mikaelyan+ (KIAE)
Translated from ZETFP 38 406.
BELIKOV 83 JETPL 38 661 +Volkov, Kochetkov, Mukhin, Sviridov+ (SERP)
Translated from ZETFP 38 547.
BELLOTTI 83 PL 121B 72 +Fiorini, Ligurori, Pullia, Sarracino+ (MILA)
BERGSMA 83 PL 122B 465 +Dorenbosch, Jonker+ (CHARM Collab.)
BERGSMA 83B PL 128B 361 +Dorenbosch+ (CHARM Collab.)
BRYMAN 83B PRL 50 1546 +Dubois, Numao, Olaniya, Olin+ (TRIU, CNRC)
Also 83 PRL 50 7 Bryman, Dubois, Numao, Olaniya+ (TRIU, CNRC)
DEUTSCH 83 PR D27 1644 +Lebrun, Prieels (LVLN)
DOI 83 PTP 69 602 +Kotani, Nishiura, Takasugi (OSAK, KYOTY)
FILIPPONE 83 PRL 50 412 +Elwyn, Davids+ (ANL, CHIC, VALP)
GRONAU 83 PR D28 2762 (HAIF)
KIRSTEN 83 PRL 50 474 +Richter, Jessberger (MPIH)
Also 83B ZPHY 16 189 Kirsten, Richter, Jessberger (MPIH)
SCHRECK... 83 PL 129B 265 Schreckenbach, Colvin+ (ISNG, ILLG)
TAYLOR 83 PR D28 2705 +Cence, Harris, Jones+ (HAWA, LBL, FNAL)
BAHCALL 82 RMP 54 767 +Huebner, Lubow+ (IAS, LANL, HPC, YALE, UCLA)
COOPER 82 PL 112B 97 +Guy, Michette, Tyndel, Venus (RL)
FILIPPONE 82 APJ 253 393 +Schramm (ANL, EFI)
FOWLER 82 A.I.P. 96 80 (CIT)
HAXTON 82 PR D25 2360 +Stephenson, Strottman (LANL, PURD)
HAYANO 82 PRL 49 1305 +Taniguchi, Yamanaka+ (TOKY, KEK, TSUK)
VUILLEUMIER 82 PL 114B 298 +Boehm, Egger+ (CIT, SIN, MUNI)
ABELA 81 PL 105B 263 +Daum, Eaton, Frosch, Jost, Kettle, Steiner (SIN)
ARMENISE 81 PL 100B 182 +Fogli-Muciaccia+ (BARI, CERN, MILA, LALO)
ASANO 81 PL 104B 84 +Hayano, Kikutani, Kurokawa+(KEK, TOKY, INUS, OSAK)
Also 81 PR D24 1232 Shrock (STON)
ASRATYAN 81 PL 105B 301 +Efremenko, Fedotov+ (ITEP, FNAL, SERP, MICH)
BAKER 81 PRL 47 1576 +Connolly, Kahn, Kirk, Murtagh+ (BNL, COLU)
Also 78 PRL 40 144 Cnops, Connolly, Kahn, Kirk+ (BNL, COLU)
BOLIEV 81 SJNP 34 787 +Butkevich, Zakidyshev, Makoev+ (INRM)
Translated from YAF 34 1418.
CALAPRICE 81 PL 106B 175 +Schreiber, Schneider+ (PRIN, IND)
DEDEN 81 PL 98B 310 +Grassler, Boeckmann, Mermikides+ (BEBC Collab.)
ERRIQUEZ 81 PL 102B 73 +Natali+ (BARI, BIRM, BRUX, EPOL, RHEL, SACL+)
HAXTON 81 PRL 47 153 +Stephenson, Strottman (PURD, LASL)
KWON 81 PR D24 1097 +Boehm, Hahn, Henrikson+ (CIT, ISNG, MUNI)
NEMETHY 81B PR D23 262 + (YALE, LBL, LASL, MIT, SACL, SIN, CNRC, BERN)
ROSEN 81 Nu Conf. Hawaii (PURD)
Also 78 RMP 50 11 Bryman, Picciotto (TRIU, VICT)
SHROCK 81 PR D24 1232 (STON)
SHROCK 81B PR D24 1275 (STON)
SILVERMAN 81 PRL 46 467 +Soni (UCI, UCLA)
SIMPSON 81B PR D24 2971 (GUEL)
USHIDA 81 PRL 47 1694 + (AICH, FNAL, KOBE, SEOU, MCGI, NAGO, OSU+)
AVIGNONE 80 PR C22 594 +Greenwood (SCUC)
BAHCALL 80 PRL 45 945 +Lubow, Huebner+ (IAS, LASL, YALE, LLL, UCLA)
Also 76 Science 191 264 Bahcall, Davis (IAS, BNL)
BOEHM 80 PL 97B 310 +Cavaignac, Feilitzsch+ (ILLG, CIT, ISNG, MUNI)
FRITZE 80 PL 96B 427 (AACH3, BONN, CERN, LOIC, OXF, SACL)
REINES 80 PRL 45 1307 +Sobel, Pasierb (UCI)
Also 59 PR 113 273 Reines, Cowan (LASL)
Also 66 PR 142 852 Nezrick, Reines (CASE)
Also 76 PRL 37 315 Reines, Gurr, Sobel (UCI)
SHROCK 80 PL 96B 159 (STON)
DAVIS 79 PR C19 2259 +Vogel, Mann, Schenter (CIT)
BLIETSCHAU 78 NP B133 205 +Deden, Hasert, Krenz+ (Gargamelle Collab.)
CROUCH 78 PR D18 2239 +Landecker, Lathrop, Reines+ (CASE, UCI, WITW)
BELLOTTI 76 LNC 17 553 +Cavalli, Fiorini, Rollier (MILA)
CONWAY 59 PR 116 1544 +Johnston (PURD)
HAMILTON 58 PR 112 2010 +Langer, Smith (IND)
JOHNSON 58 PR 112 2004 +Johnson, Langer (IND)

Neutrino Bounds from Astrophysics and Cosmology

OMITTED FROM SUMMARY TABLE

The limits on the number of light neutrino types now appears in a separate section (following the τ-lepton section).

See the note on neutrinos by R.E. Shrock in the ν_e section near the beginning of these Listings. For additional information see the ν_e, ν_μ, ν_τ, and heavy-ν sections above.

NOTE ON CONSTRAINTS ON PARTICLES FROM SN 1987A

(by J. Ellis, CERN and D.N. Schramm, Univ. of Chicago)

Since there have been few new developments in 1992–94, the text of this note is omitted. The reader is referred to the 1992 edition (Phys. Rev. **D45**, VI. 42 (Part II, June 1992)).

ν MASS

The limits on low mass ($m_\nu \lesssim 1$ MeV) neutrinos apply to $m_{\rm tot}$ given by

$$m_{\rm tot} = \sum_\nu (g_\nu/2) m_\nu \ ,$$

where g_ν is the number of spin degrees of freedom for ν plus $\overline{\nu}$: $g_\nu = 4$ for neutrinos with Dirac masses; $g_\nu = 2$ for Majorana neutrinos. The limits on high mass ($m_\nu > 1$ MeV) neutrinos apply separately to each neutrino type.