

Subir Sarkar



Born 12th September 1953, Ichapur, India

Secondary education at the Central School, Ambarnath, 1963–69;
All India Higher Secondary School Examination Certificate, 1969

Undergraduate & graduate studies at the [Indian Institute of Technology, Kharagpur](#), 1969–74;
B.Sc. in Physical Sciences, 1972; M.Sc. in Physics, 1974

Research at the [Tata Institute of Fundamental Research \(TIFR\), Bombay](#), 1974–82;
Ph.D. in Physics, [University of Bombay](#), 1982 (Thesis: '*High energy astrophysics of supernova remnants*')
Research Associate in the Cosmic Rays Group, 1979–84

Visiting Fellow, [Astrophysics Sector, International School of Advanced Studies \(SISSA\), Trieste](#), 1983

Research Associate, [Theory Division, Conseil Européen pour la Recherche Nucléaire \(CERN\), Geneva](#), 1984–85

Visiting Fellow, [Department of Astrophysics, University of Oxford](#), 1985–86

Research Associate, [HEP Theory Group, Rutherford Appleton Laboratory, Chilton](#), 1987–88

Staff member, '[Eklavya](#)', [Bhopal](#), 1988–89

Staff Member, [Rudolf Peierls Centre for Theoretical Physics, University of Oxford](#), since 1990
Glasstone Fellow 1990–92; Visiting Scholar, [Wolfson College, Oxford](#) 1991–93; Particle Physics and Astronomy
Research Council Advanced Fellow 1992–97; Research Fellow, [Wolfson College, Oxford](#) 1993–97;
Departmental Lecturer in Astroparticle Physics 1997–98; Tutor in Physics, [Pembroke College, Oxford](#) 1997–98

Present position: University Lecturer in [Physics](#) & Fellow of [Linacre College, Oxford](#) 1998–; Reader 2000–; Professor 2006–; [Science & Technology Facilities Council](#) Senior Fellow 2006–09; Head, [Particle Theory Group](#) 2011–

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Referees:

[Prof John Ellis FRS](#),

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[Prof Edward Kolb](#), Chair, Department of Astronomy and Astrophysics,

The University of Chicago, 5640 South Ellis Avenue, Chicago, IL 60637 USA.

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[Prof Graham Ross FRS](#),

Theoretical Physics, 1 Keble Road, Oxford OX1 3NP, UK

Tel: +44-1865-273968, Fax: +44-1865-273947, Email: g.ross@physics.ox.ac.uk

Personal Details:

My wife [Amanda Cooper-Sarkar](#) is a particle physicist, presently involved with [ZEUS](#) at DESY and with [ATLAS](#) at CERN. She is Professor of Physics and Fellow of [St. Hilda's College, Oxford](#). Our daughter Shanti is 22 and studying [Theatre at Exeter University](#) and our son Harry is 16 and at [Oxford & Cherwell Valley College, Oxford](#).

My extracurricular interests include yoga and martial arts — I hold the rank of *ni-dan* in Goju-ryu karate, awarded by the [Japan Karate-do Federation](#). I am a Trustee of the [Bhopal Medical Appeal](#).

Research Experience:

My research career began at TIFR, in experimental cosmic ray physics, using plastic track detectors flown on balloons [1] and the *SKYLAB* satellite. Using the Earth's magnetic field as a momentum filter we established that heavy nuclei in low energy cosmic rays are not fully ionised, suggesting a relatively local origin for such particles [162]. I helped to design an experiment (*Anuradha*) which had a slowly rotating detector stack to provide time resolved measurement of the momentum spectrum and was subsequently flown on *SPACELAB III*.

For my PhD thesis I switched to investigating theoretical problems in high energy astrophysics, in particular cosmic ray acceleration by stochastic plasma processes and the non-thermal radiation which provide probes of such environments. By combining radio and γ -ray observations of young supernova remnants we demonstrated that the magnetic field has been amplified well over the compressed interstellar field [2]. We showed that second-order Fermi acceleration by plasma turbulence due to the deceleration of the supernova blast wave yields the observed power-law electron spectrum and explains the rapid rise in synchrotron luminosity (accompanied by spectral flattening) of young remnants [4]. I found that old remnants which have expanded to large sizes in the hot interstellar medium can account for the 'diffuse' synchrotron radio emission from the Galaxy, thus reconciling the magnetic field strength obtained from Faraday rotation with the higher value usually inferred from the intensity of the radio background [3].

In my post-doctoral career at Oxford, SISSA, CERN and RAL, I worked on cosmology, particularly at its interface with high energy physics. All particles, known or hypothesised, would have been created in the early universe; analysis of their possible effects on cosmological observables such as the cosmic microwave background and the primordially synthesised light element abundances, enables interesting constraints to be derived on their properties. The production and interactions of particles can also have observable effects in astrophysical objects such as supernovae. Such arguments provide useful guidance on physics beyond the Standard Model [23, 165, 166, 176].

For example by combining cosmological constraints on an unstable tau neutrino with laboratory bounds on leptonic mixing we noted that the ν_τ must be stable against weak decays, hence lighter than $2m_e$ [6]. We showed that the thermal production of massive gravitinos can be disastrous for the standard cosmology, implying a severe upper bound on the temperature to which the universe reheated at the end of inflation [7, 13]. The 'gravitino bound' has proved to be an important constraint on thermal leptogenesis which is an attractive possibility motivated by the discovery of neutrino mass [34]. New light particles, e.g. a light photino or Higgsino would have been produced by nucleon bremsstrahlung in SN 1987A and are constrained by the energetics of the observed neutrino emission [12] as well as nucleosynthesis [152]. We discussed the cosmology of sterile neutrinos for which there have been experimental indications e.g. the 17 keV state seen in ^3H β -decay [14] and the 33.9 MeV '*KARMEN* anomaly' [19, 22, 37]. I investigated the astrophysical and cosmological consequences of $n - \bar{n}$ oscillations and showed that these can have no observable effects on primordial nucleosynthesis or account for a possible excess of antiprotons in low energy cosmic rays [5]. Perturbative SUSY breaking at the Fermi scale is cosmologically problematic [18]. We showed that the next-to-minimal-supersymmetric standard model suffers from a domain wall problem [21]. The domain wall network will decay if there is a 'bias' between the vacua [26], as might be introduced due to a prior period of inflation [42].

We were the first to propose that quantum gravity effects might be detectable by looking for energy dependent arrival time dispersion in cosmologically distant γ -ray bursts [30]. Such high energy violations of Lorentz invariance may also be seen as altered flavour ratios of cosmic neutrinos from the large-angle mixing base expectation [52].

We calculated the error correlation matrix for Big Bang nucleosynthesis [31] and emphasised systematic uncertainties in inferring the primordial abundances [24, 178, 184, 187, 189, 191, 170, 173, 182] which allow an additional light neutrino (or equivalent particle) type [35, 193]. Using this we have imposed constraints on an additional Z' to which singlet neutrinos are coupled [10], on a 'time-varying cosmological constant' [25] and on possible changes in the baryon/photon ratio after nucleosynthesis [29].

The nature of the dark matter is a fundamental question [167]. An attractive particle candidate is the lightest supersymmetric state, usually the neutralino in the Minimal-Supersymmetric-Standard-Model, but this is now tightly constricted. We considered extended models in which electroweak symmetry breaking is seeded by a gauge singlet — the neutralino (with a 'singlino' component) can then be relatively light [17]. Alternatively the dark matter may consist of very massive metastable particles e.g. 'cryptons' (bound states from the hidden sector of SUSY breaking). The high energy neutrino flux from their decays is detectable in underground experiments and requires such particles to have lifetimes $> 10^{16}$ yr [13, 16]. When ultrahigh energy cosmic rays were detected beyond the GZK cutoff [175, 180] we proposed that these arise from the slow decays of cryptons clustered in the galactic halo — the observed spectrum is well matched by that expected from QCD fragmentation [32], while the expected small anisotropy in arrival directions should be detectable with forthcoming data [40]. Sciama's proposal for light neutrinos which both constitute (hot) dark matter and ionise the IGM through their slow decays is ruled out by observations of small-angle CMB anisotropy [33]. We emphasised that dwarf spheroidals orbiting the Milky Way are the best targets for looking for gamma-ray annihilation signatures of dark matter [47, 134], rather than the Galactic centre [49]. However the *PAMELA* anomaly is unlikely to be such a signal, rather it indicates the presence of a nearby

SNR accelerating cosmic rays [91, 96]. The ‘WMAP haze’ is also likely to be an artefact of the template subtraction process [108], while the ‘Fermi bubbles’ likely have an astrophysical origin [135]. Dark matter may in fact have an asymmetry like baryons [119] — accreted particles can then affect heat transport in the Sun and solve the ‘Solar composition problem’ as well as alter neutrino fluxes [103]. Such light particles may arise in models of new strong dynamics [133] and have different couplings to protons and neutrons as may be necessary to reconcile the recently seen signals in *DAMA*, *CoGeNT* and *CRESST* with the upper limits from *XENON* [141], as astrophysical uncertainties alone cannot reconcile these results [151].

Another of my interests is developing models of inflation based on field theory, in particular supergravity. Gravitino overproduction is avoided if the inflaton is in the hidden sector [20] and its potential can be made sufficiently flat by employing a Goldstone mode [27]. Taking non-renormalisable terms in the inflaton potential into account, inflation can occur at the electroweak scale and still generate the correct amplitude of density perturbations [36, 41]. Topological inflation can be realised in the racetrack model and also solve the dilaton runaway problem [57]. Moreover, other scalar fields may undergo symmetry breaking phase transitions during inflation, introducing sharp spectral features [28, 51] and non-Gaussianity [97]. Such breaking of scale-invariance can affect cosmological parameter extraction from CMB and LSS data, in particular doing away with the need for dark energy [39, 46, 68, 80, 177]. I have been investigating such models in detail because dark energy may be just an artifact of interpreting data in an oversimplified model framework [186, 71]. In fact all the data can be fitted in a LTB model without dark energy [123].

I have continued my interest in experimental physics. When ‘monojet’ events at *UA1* were interpreted as due to unstable light gluinos, we searched for these in the *BEBC* beam dump and ruled them out [8]. We obtained correlated bounds on the masses and mixing angles of massive neutral leptons [9] and set a bound on the magnetic moment of ν_τ s from the absence of forward scattering events in *BEBC* [15].

I belong to the international collaboration which operates the *Pierre Auger Observatory* in Argentina for the study of ultra-high energy cosmic rays [104, 100, 94]; this has obtained several exciting results such as detecting the GZK suppression in the energy spectrum [79, 102] and a correlation between the arrival directions and nearby active galactic nuclei [72, 76, 139], as well as setting bounds on galactic anisotropy [60], UHE photons [58, 74, 88] and UHE neutrinos [75, 89]. I am also a member of the *IceCube* collaboration which has constructed a km³ detector for high energy cosmic neutrinos under the South Pole [55, 83, 95, 105, 106]; this has measured the atmospheric neutrino flux [67, 85, 107] and set stringent bounds on the diffuse cosmic flux [66, 73], point sources [62, 81, 99] (in particular stellar flares [59, 82] and γ -ray bursts [63, 65, 84, 93]), dark matter annihilations in the Sun [86, 98, 154] and non-standard neutrino oscillations [85]. Such experiments can measure the UHE neutrino cross-section [56] and thus probe QCD dynamics at very low Bjorken- x [70, 140]. Another key target is the detection of the ‘cosmogenic’ neutrino flux [50, 69, 87, 110] which we have computed through a precise description of the intergalactic propagation of UHE cosmic rays [61, 77]. I am participating in the the *Cherenkov Telescope Array* project which will seek to detect high energy cosmic γ -rays from a variety of astrophysical sources, addressing astrophysical questions (e.g. the origin of cosmic rays) as well as fundamental physics issues such as dark matter and tests of Lorentz invariance [195].

In summary, my research interests are focussed on particle astrophysics and cosmology. My key contributions have been in cosmic ray phenomenology, in using the early universe as a laboratory for new physics, in seeking an understanding of dark matter and dark energy, and in experimentally probing the nature of quantum gravity.

Invited Talks at Conferences & Workshops:

1. ICHEP 85: International Conference on High Energy Physics, Bari, Jul 1985
2. ISMD 86: XXVI International Symposium on Multiparticle Dynamics, Seewinkel, Jun 1986 [166]
3. Annual UK High Energy Physics Theory Meeting, Rutherford Appleton Laboratory, Chilton, Dec 1987
4. NATO Advanced Study Institute: ‘*Observational Tests of Cosmological Inflation*’, Durham, Dec 1990 [167]
5. Annual UK High Energy Physics Theory Meeting, Rutherford Appleton Laboratory, Chilton, Dec 1990
6. UK HEP Cosener’s House Forum: ‘*Dark Matter*’, Abingdon, Jun 1991
7. UK Institute of Physics Discussion Meeting: ‘*Dark Matter*’, London, Jun 1991
8. NORDIC meeting on Theoretical Physics, Copenhagen, Aug 1993
9. XI DAE Symposium on High Energy Physics, Shantiniketan, Jan 1994
10. UK HEP Forum: ‘*New Horizons in Astroparticle Physics*’, Abingdon, Feb 1994
11. UK HEP Forum: ‘*Particle Cosmology*’, Abingdon, Jun 1994

12. Royal Astronomical Society Discussion Meeting: '*Neutron Stars*', London, Jan 1995
13. UK National Astronomy Week, Cardiff, Apr 1995
14. Inaugural Conference of the Asia-Pacific Centre for Theoretical Physics, Seoul, Sep 1996 [171]
15. WHEPP 96: Fourth Workshop on High Energy Physics Phenomenology, Calcutta, Jan 1996
16. DARK 96: International Workshop on '*Dark Matter in Astro- & Particle Physics*', Heidelberg, Sep 1996 [170]
17. WIN 07: XVI International Workshop on '*Weak Interactions & Neutrinos*', Capri, Jun 1997 [172]
18. International Workshop on '*Synthesis of Nuclei in the Early Universe*', Trento, Jun 1997
19. ICTP Workshop on '*Highlights in Astroparticle Physics*', Trieste, Nov 1997
20. UK Institute of Physics Annual Conference, Manchester, Apr 1998
21. CAPP-98: International Workshop on '*Cosmology & Particle Physics*', Geneva, Jun 1998
22. DARK 98: International Workshop on '*Dark Matter in Astro- & Particle Physics*', Heidelberg, Jul 1998
23. NOW 98: European Physical Society *Neutrino Oscillation Workshop*, Amsterdam, Sep 1998 [193]
24. ICTP Workshop on '*The Physics of Relic Neutrinos*', Trieste, Sep 1998
25. DESY Theory Workshop: '*Directions Beyond the Standard Model*', Hamburg, Oct 1998
26. JENAM'99: Joint European & National Astronomical Meeting, Toulouse, Sep 1999
27. COSMO-99: International Workshop on '*Particle Physics & the Early Universe*', Trieste, Oct 1999 [175]
28. Landelijk Seminarium, NIKHEF, Amsterdam, Dec 1999
29. Annual UK High Energy Physics Theory Meeting, Rutherford Appleton Laboratory, Chilton, Dec 1999
30. Nordic Workshop on '*Neutrino physics & Cosmology*', Copenhagen, Apr 2000
31. Summer Institute on '*Dark Matter & Supersymmetry*', Gran Sasso, Jul 2000
32. XIIIèmes Recontres des Blois: '*Frontiers of the Universe*', Blois, Jun 2001 [182]
33. International Workshop: '*The Physics of Extra Dimensions*', Paris, Jun 2001
34. International Conference on '*Deuterium in the Universe*', Meudon, Jun 2001
35. ICHEP 01: International Europhysics Conference on High Energy Physics, Budapest, Jul 2001 [179]
36. COSMO-01: International Workshop on '*Part. Phys. & the Early Universe*', Rovaniemi, Sep 2001 [180]
37. IUCAA Workshop on '*Interface of Gravitational & Quantum Realms*', Pune, Dec 2001 [44]
38. NORDITA Meeting on Astroparticle Physics & Cosmology, Copenhagen, Mar 2002
39. Planck 01: International Conference on '*Supersymmetry & Brane Worlds*', Kazimierz, May 2002
40. Workshop on '*Cosmoseismology & Entropy Perturbations*', Portsmouth, Jun 2002
41. International Conference on '*String/M-theory Phenomenology*', Oxford, Jul 2002
42. International Workshop on '*Branes, Gravity, ...: New Interfaces*', London, Sep 2002
43. HEP 2003: Workshop on High Energy Physics and Cosmology, Athens, Apr 2003
44. Planck 03: International Conf. on '*From the Planck Scale to the Electroweak Scale*', Madrid, May 2003
45. CAPP-2003: International Workshop on Cosmology & Particle Physics, Geneva, Jun 2003
46. Claude Itzykson meeting: '*Which Model(s) for the Early Universe?*', Saclay, Jun 2003
47. Eötvös Graduate Course and Workshop in Physics, Balatonfüred, Jun 2003 [183]
48. ISMD 03: XXXIII International Symposium on Multiparticle Dynamics, Krakow, Sep 2003 [181]
49. International Workshop on Astroparticle & High Energy Physics, Valencia, Oct 2003
50. 315th WE-Heraeus-Seminar: '*Dark Matter and Dark Energy*', Bad Honnef, Dec 2003

51. Institute of Physics UK Particle Physics Conference 2004, Birmingham, Apr 2004
52. Planck 04: International Conf. *'From the Planck Scale to the Electroweak Scale'*, Bad Honnef, May 2004
53. International Conference on *'The density Perturbation in the Universe'*, Athens, Jun 2004 [185]
54. International Workshop: *'Terrestrial and Cosmic Neutrinos, leptogenesis and Cosmology'*, Benasque, Jul 2004
55. ISVHECRI 04: XIII International Symposium on *'Very High Energy Cosmic Ray Interactions'*, Pylos, Sep 2004
56. UK High Energy Physics Forum on *'Cosmic Particles'*, Abingdon, Feb 2005
57. SNS Pisa-UCLA Workshop on *'Cosmic Connections'*, La Magia, Apr 2005
58. Montpellier-Toulouse meeting on *'Dark Energies, Dark matters'*, Paris, Apr 2005
59. PASCOS'05: International Conference on *'Particles, Strings & Cosmology'*, Gyeongju, Jun 2005
60. COSMO 05: International Workshop on *'Particle Physics & the Early Universe'*, Bonn, Sep 2005
61. European Astroparticle Physics Town Meeting, Munich, Nov 2005
62. International Conference on *'From Strings to Cosmic Web'*, Groningen, Dec 2005
63. Cosmology 2005: *'A Reality Check'*, Copenhagen, Dec 2005
64. XI IFT-UAM/CSIC Christmas Workshop on *Particle Physics*, Madrid, Dec 2005
65. Workshop on *High Energy Physics Phenomenology*, Bhubaneshwar, Jan 2006 [194]
66. Sixth National Astroparticle Symposium, Amsterdam, Feb 2006
67. Workshop on *'Recent Developments in High Energy Physics & Cosmology'*, Ioannina, Apr 2006
68. ToK Workshop on *'Particle Physics & Cosmology'*, Warsaw, May 2006
69. Institute of Physics UK, Astroparticle Group meeting, Sheffield, May 2006
70. International Workshop on *'The Dark Side of the Universe'*, Madrid, Jun 2006
71. International Conference on *'Quantum ... Gravity and Cosmology'*, Barcelona, Jul 2006
72. DESY Theory Workshop: *'The Dark Universe'*, Hamburg, Sep 2006
73. International Conference on *'Outstanding questions for the standard cosmological model'*, London, Mar 2007
74. *'From IRAS to Herschel/Planck'*, London, Jul 2007
75. ASPERA workshop for the Astroparticle Roadmap, Phase II, Paris, Jul 2007
76. COSMO 07: International Workshop on *'Particle Physics & the Early Universe'*, Falmer, Aug 2007
77. TRR-33 Workshop: *'The Dark Universe'*, Bad Honnef, Oct 2007
78. AMT Workshop: *'Questions for the Universe'*, Toulouse, Nov 2007
79. ICGC 07: International Conference on Gravitation & Cosmology, Pune, Dec 2007
80. Rencontre des Particules, Annecy, Jan 2008
81. Workshop on *'Nu Horizons'*, Allahabad, Feb 2008
82. International Workshop on *'Quarks in astrophysics and cosmology'*, Puri, Feb 2008
83. Nordic Workshop on *'Field Theoretical Applications in Cosmology'*, Copenhagen, Mar 2008
84. Workshop on *'Neutrino Horizons in the 21st Century'*, Abingdon, Apr 2008
85. International Conference on *'Progress on Old and New Themes in Cosmology'*, Avignon, Apr 2008
86. Neutrino 08: XXIII International Conf. on *Neutrino Physics & Astrophysics*, Christchurch, May 2008 [188]
87. International Conference on *'Quantum Geometry & Quantum Gravity'*, Nottingham, Jul 2008
88. International Conference on *'Dark Energy and Dark Matter'*, Lyon, Jul 2008 [190]
89. ICTS Workshop: *'Cosmology with CMB and LSS'*, Pune, Aug 2008

90. ICTS Workshop: '*QCD at High Parton Density*', Panjim, Sep 2008
91. ISSI Workshop: '*The Nature of Gravity*', Bern, Oct 2008
92. Royal Astronomical Society Discussion Meeting: '*Galaxies and the Elements*', London, Nov 2008
93. Institute of Physics UK Meeting: '*Searching for Dark Matter Underground & at the LHC*', London, Dec 2008
94. WAPP-08: Workshop on Astroparticle Physics, Ootacamund, Dec 2008
95. ToK Workshop on '*Particle Physics and Cosmology*', Warsaw, Feb 2009
96. Eleventh National Astroparticle Symposium, Leiden, March 2009
97. ICTS Workshop: '*Neutrinos in Particle Astrophysics and Cosmology*', Mahabalipuram, Apr 2009
98. NBI Workshop: '*Cosmology and astroparticle physics from the LHC to PLANCK*', Copenhagen, Jun 2009
99. CHIPP Workshop: '*Astroparticle Physics*', Lausanne, Jun 2009
100. PPAP Meeting: '*Neutrino & Non-accelerator Physics*', Birmingham, Jul 2009
101. Lorentz Centre Workshop: '*Universe in a Box : LHC, Cosmology & Lattice Field Theory*', Leiden, Aug 2009
102. Workshop on '*Origin of mass*', Odense, Nov 2009
103. HEAP 2009: '*Cosmic Particles, Jets and Accelerator Science*', Tsukuba, Nov 2009
104. WAPP-09: Workshop on Astroparticle Physics, Darjeeling, Dec 2009
105. Workshop on '*The new, the rare and the beautiful*', Zurich, Jan 2010
106. DISCOVERY Centre inauguration, Copenhagen, Jan 2010
107. ToK Workshop on '*Particle Physics & Cosmology*', Warsaw, Feb 2010
108. Workshop on '*Frontiers of Cosmology*', Heraklion, Apr 2010
109. Workshop on '*Cosmology and astroparticle physics from the LHC to PLANCK*', Copenhagen, Jun 2010
110. NEB 14: '*Recent developments in gravity*', Ioannina, Jun 2010
111. PPC 2010: Workshop on the interconnection between particle physics & cosmology, Torino, Jul 2010
112. TeVPA-10: International conf. on TeV Particle Astrophysics, Paris, Jul 2010
113. '*Darkness visible*': Workshop on dark matter in astrophysics & particle physics, Cambridge, Aug 2010
114. '*Confronting theory with observations*': UniverseNet cosmology workshop, Copenhagen, Aug 2010
115. SUSY10: 18th Intern. Conf. on '*Supersymmetry & Unification of Fundamental Interactions*', Bonn, Aug 2010
116. WAPP-10: Workshop on Astroparticle Physics, Ootacamund, Dec 2010
117. Workshop on '*Dark Matter in the LHC Era: Direct and Indirect Searches*', Kolkata, Jan 2011
118. NuTel'11: XIV International Workshop on '*Neutrino Telescopes*', Venice, Mar 2011
119. IoP Nuclear & Particle Physics Divisional Conf., Glasgow, Apr 2011
120. Workshop on '*Cosmology & astroparticle physics from the LHC to PLANCK*', Copenhagen, Jun 2011
121. NuSky2011: International Workshop on '*Cosmic Rays & Cosmic Neutrinos*', Trieste, Jun 2011
122. TeVPA-11: Workshop on '*TeV Particle Astrophysics*', Stockholm, Aug 2011
123. ICRC2011: 32nd International Cosmic Ray Conference, Beijing, Aug 2011
124. XXV International Symposium on Lepton Photon Interactions, Mumbai, Aug 2011
125. RAS Specialist Discussion Meeting, '*Exploring the Non-Thermal Universe*', London, Nov 2011
126. HEAP 2011: '*Gamma-ray universe: Fermi to CTA*', Tsukuba, Nov 2011
127. OPERA versus Maxwell and Einstein' event, King's College London, Nov 2011
128. CTA Consortium Meeting, Univ Complutense Madrid, Nov 2011

129. *'Amazing Particles and Light: Horizons in Accelerators and Enabled Sciences'*, Bangalore, Dec 2011
130. *Advances in Astroparticle Physics & Cosmology*, Darjeeling, Mar 2012
131. *National Symposium on Particles, Detectors and Instrumentation*, Mumbai, Mar 2012

Invited Lectures at Schools:

1. ICTP Summer School in 'High Energy Physics & Cosmology', Trieste, Jul 1985 [165]
2. Scuola Internazionale Superiore Studi Avanzati (SISSA) Graduate School, Trieste, Jul 1986
3. GIFT School in Theoretical Physics, Peniscóla, Aug 1986
4. Adriatic School on High Energy Physics, Split, Jun 1987
5. Centro Fundamental Materia Condensada (CFMC) Graduate School, Lisbon, Mar 1992
6. Spring School in High Energy Physics & Cosmology, Tenerife, May 1992
7. Tata Institute of Fundamental Research (TIFR) Graduate School, Bombay, Aug 1993
8. Indian Institute of Astrophysics (IoA) Graduate School, Bangalore, Dec 1994,
9. BCSPIN/ICTP Summer School in Physics, Kathmandu, May 1997
10. Autumn School on Theoretical Physics, Santiago de Compostela, Sep 1997
11. XIX UK Institute for Theoretical High Energy Physicists, Oxford, Aug 1998
12. Graduiertenkolleg on Cosmology & Statistical Physics, Heidelberg, Nov 1998
13. IPM School on Large-scale structure formation, Kish, Jan 1999 [174]
14. Bruno Pontecorvo School on Elementary Particles, Capri, May 1999
15. Finnish Particle Cosmology School, Kiljavanranta, Aug 1999
16. NATO Advanced Study Institute: Particle Physics & Cosmology, Cascais, Jul 2000 [176]
17. British Universities Summer School in Elementary Particle Physics, Oxford, Sep 2000
18. British Universities Summer School in Elementary Particle Physics, Manchester, Sep 2001
19. International Graduate School in Mathematics & Physics, Bonn, Jan 2002
20. ICTP Summer School on 'Particle Physics & Cosmology', Trieste, Jul 2002
21. Second Crete School on 'String theory', Kolymbari, June 2003
22. Second Aegean School on the 'Physics of the Early Universe', Syros, Sep 2003
23. CERN Summer Student Programme, 'Introduction to Cosmology', Geneva, Aug 2004
24. Third Aegean School on the Physics of the Early Universe, Chios, Sep 2005
25. CERN Summer Student Programme, 'Introduction to Cosmology', Geneva, Jul 2006
26. Nordic Winter School in Particle Physics & Cosmology, Gausdal, Jan 2007
27. CERN Summer Student Programme, 'Introduction to Cosmology', Geneva, Jul 2007
28. CERN Summer Student Programme, 'Introduction to Cosmology', Geneva, Jul 2008
29. ICTS School: 'Cosmology with CMB and LSS', Pune, Aug 2008
30. ICTS School: 'QCD at High Parton Density', Dona Paula, Sep 2008
31. Les Houches School: 'Searching for Dark Matter', Les Houches, Mar 2009
32. Corfu Summer School: 'Standard Model & Beyond Standard Cosmology', Corfu, Sep 2009
33. DPG Physics School: 'Astroparticle Physics', Bad Honnef, Sep 2009
34. Winter School in Astroparticle Physics, Darjeeling, Dec 2009

35. YETI School in Astroparticle Physics, Durham, Jan 2009
36. Taller de Altas Energias: 'Astroparticle Physics', Barcelona, Sep 2010
37. CORSIKA Winter School in Astroparticle Physics, Ooty, Dec 2010
38. Corfu Summer Institute: 'Unification in the LHC Era', Corfu, Sep 2011

D.Phil Theses Supervised:

1. [Kevin C. Benson](#), Wadham College, Oxford University, 1991–93
(Thesis: '*Aspects of the electroweak phase transition & baryogenesis*')
2. [Jennifer A. Adams](#), Magdalen College, Oxford University, 1992–95
(Thesis: '*Cosmological phase transitions: techniques & applications*')
3. [Sebastian E. Larsson](#), Christ Church College, Oxford University, 1993–98
(Thesis: '*Topological defects from cosmological phase transitions*')
4. [Michael Birkel](#), Linacre College, Oxford University, 1994–97
(Thesis: '*Astroparticle physics beyond the Standard Model*')
5. [Fermin Viniegra](#), Worcester College, Oxford University, 1997–2001
(Thesis: '*Reheating in inflationary cosmology*') Joint supervisor with B Bassett
6. [Mario Santos](#), Wadham College, Oxford University, 1999–2003
(Thesis: '*Primordial effects in the CMB*') Joint supervisor with P Ferreira
7. [David Skinner](#), Linacre College, 1999–2003
(Thesis: '*Cosmology of heterotic M-theory*')
8. [Paul Hunt](#), St John's College, 2000–06
(Thesis: '*The cosmological implications of multiple inflation*')
9. [Andrew Taylor](#), Linacre College, 2003–06
(Thesis: '*The intergalactic propagation of ultrahigh energy cosmic rays*') Joint supervisor with Prof J Silk
10. [Francesco Riva](#), Merton College, 2004–08
(Thesis: '*Cosmological consequences of supersymmetric flat directions*') Joint supervisor with J March-Russell
11. [Shaun Hotchkiss](#), Balliol College, 2006–10
(Thesis: '*Inflation: beyond the scalar fluctuation power spectrum*')
12. [Philipp Mertsch](#), Balliol College, 2007–10
(Thesis: '*Cosmic ray backgrounds for dark matter indirect detection*')
13. [Seshadri Nadathur](#), Merton College, 2007–11
(Thesis: '*Inflation, large-scale structure & inhomogeneous cosmologies*')

Refereeing

Appointments & Promotions: CERN, Geneva; Demokritos, Athens; DESY, Zeuthen; HRI, Allahabad; IMSc, Chennai; ICTP, Trieste; King's College, London; Lancaster University; LAPTH, Annecy; NTU Athens; Penn State University; RRI, Bangalore, SINP Kolkata; TIFR Mumbai; Universität Aachen; University of Athens; University of Crete; Universität Dortmund; University of Edinburgh; Universität Göttingen; University of Geneva; Universität Hamburg; Universität Karlsruhe; University of Nottingham; Universität Potsdam; Universität Wuppertal; Universität Zurich

Book proposals: Cambridge University Press, Oxford University Press

Journals: Astronomy & Astrophysics, Astrophysical Journal, Astroparticle Physics, Astrophysics & Space Science, Classical & Quantum Gravity, Computer Physics Communications, Europhysics Letters, Journal of Cosmology & Astroparticle Physics, Journal of High Energy Physics, International Journal of Modern Physics, Modern Physics Letters, Monthly Notices of the Royal Astronomical Society, Nature, Nuclear Physics B, Physics Letters B, Physical Review D, Physical Review Letters, Pramana, Reports on Progress in Physics, Science

Grant applications: Academy of Finland; Agence Nationale de la Recherche, France; Alexander von Humboldt Stiftung, Germany; Australian Research Council; Department of Atomic Energy, India; Department of Energy, USA; Department of Science & Technology, India; Engineering & Physical Sciences Research Council, UK; European Space Agency; Fondazione Cariparo, Italy; Fundamenteel Onderzoek der Materie, Netherlands; Istituto Nazionale di Fisica Nucleare, Italy; Leverhulme Foundation, UK; Ministry of Education, Greece; Newton Institute, Cambridge; Royal Society of New Zealand; Royal Society, UK; Science & Technology Facilities Council, UK; Swiss National Foundation

Service on External Committees

- [Particle Data Group](#), Astrophysics & Cosmology section, 2001–
- CNRS Comite d'Evaluation, 2005–; [Agence d'Evaluation de la Recherche et de l'Enseignement Superieur](#), 2009–
- [Oxford University](#): Joint Committee on Physics & Philosophy, 2005–07 (Chair 2006–07); India Strategy Working Group, 2006–08, 2010–; Glasstone Fellowships Committee 2008–12 (Chair 2011–12)
- [Astroparticle Physics European Coordination \(ApPEC\)](#): Peer Review Committee, 2005–
- [European Research Area Network on Astronomy \(Astronet\)](#): Science Vision Working Group (Panel A), 2006–08
- [Astroparticle Physics European Research Area Network \(ASPERA\)](#): Working Groups on 'High energy cosmic rays' and 'High energy neutrinos', 2007–09; Evaluation Committee, 2009; Science Advisory Committee, 2010–
- [Institute of Physics UK, Astroparticle Physics Group](#): Steering Committee, 2006–08
- Chair, Astroparticle Physics Panel, [STFC Programmatic Review](#), 2008
- International Peer Review Panel in Physics & Astronomy, [Danish Council for Independent Research](#), 2010 –
- Review Panel on Astroparticle Physics, [Helmholtz Gemeinschaft, Germany](#), 2011

Organisation of Conferences, Schools & Workshops:

> Main Organiser:

- UK Theoretical Cosmology Network meeting, Oxford, 15 May 1996
- UK Theoretical Cosmology Network meeting, Oxford, 26 Mar 1997
- UK Theoretical Cosmology Network meeting, Oxford, 20 May 1998
- [EU Network School on 'The Early Universe'](#), Oxford, 26–29 Sep 2002
- [IceCube collaboration meeting](#), Oxford, 21–24 Sep 2005
- [ASPERA Workshop on 'Theory and Astroparticle Physics'](#), Oxford, 17 Mar 2008
- [EU Network School: 'Fundamental Physics & Cosmology'](#), Oxford, 22–26 Sep 2008
- [LINK Workshop: 'Probing Physics beyond the Standard Model with CTA'](#), Abingdon, 12 Nov 2010
- Astroparticle Physics session, [RAS National Astronomy Meeting](#), Llandudno, 17-21 Apr 2011
- [GrahamFest](#), Oxford, 30 Sep 2011
- [New paths to particle dark matter](#), Oxford, 29-30 Mar 2012

> Co-organiser:

- UK Institute for Theoretical High Energy Physics, Cambridge, 1–7 Sep 1991
- ['Cosmology after COBE'](#), Abingdon, 20–21 Jun 1992
- Parallel session on ['Particle Physics, Astrophysics and Cosmology'](#), International Europhysics Conference on High Energy Physics, Brussels, 28 Jul–3 Aug 1995
- Parallel session on ['Particle Physics, Astrophysics and Cosmology'](#), 28th International Conference on High Energy Physics, Warsaw, 25–31 Jul 1996
- [SUSY 98](#), Oxford, 11-17 Jul 1998
- ['New Horizons in Neutrino Physics'](#), Abingdon, 8–9 May 1999
- [EU Network School on 'The Early Universe'](#), CERN, 19–22 Apr 2001
- [IPPP Workshop on 'Phenomenology of Ultra-high-energy Cosmic Rays'](#), Dept of Physics, Durham, 21 June 2002
- ['String/M-theory Phenomenology'](#), Oxford, 6–11 Jul 2002
- Workshop on ['The World According to WMAP'](#), Abingdon, 7–8 Jun 2003
- Kogan Memorial Meeting: ['From Fields to Strings'](#), Oxford, 8–10 Jan 2004
- Astrophysics/Cosmology Session, [SUSY'05](#), Durham, 18–23 Jul 2005
- ['Dalitz Memorial Meeting'](#), Oxford, 3 Jun 2006
- [UK Neutrino Network](#) meeting, Oxford, 29 Nov 2006

- EU Network School on '*The Origin of the Universe*', Mytilene, 24–29 Sep 2007
- IoP/RAS meeting on '*The Search for Dark Matter*', London, 26 Nov 2007
- *Astroparticle Physics UK* meeting, Oxford, 18–20 Jun 2008
- '*Cosmology with the CMB & LSS*', Pune, 18–31 Aug 2008
- '*Neutrino & Non-accelerator Physics*', PPAP Community Meeting, Birmingham, 15 July 2009
- Summer School: '*Standard Model & Beyond*', Corfu, 30 Aug–6 Sep 2009
- EU Network School '*Particle Physics & Cosmology*', Barcelona, 28 Sep–2 Oct 2009
- Summer School: '*Standard Model & Beyond*', Corfu, 29 Aug–5 Sep 2010
- EU Network School '*Frontiers of Particle Cosmology*', Lecce, 13–18 Sep 2010
- ICATPP Conference on '*Cosmic Rays for Particle and Astroparticle Physics*', Como, 7–8 Oct 2010
- '*Cherenkov Telescope Array*' Collaboration Meeting, Rutherford Lab, 8–11 Nov 2010
- '*Looking at the Neutrino Sky*', Trieste, 20–24 Jun 2011
- '*Dark Matter Underground and in the Heavens*', Geneva, 18–29 Jul 2011
- XII Workshop on High Energy Physics Phenomenology, Mahabaleshwar, 2–8 Jan 2012

> **Member of International Advisory Committee:**

- '*Trends in Astroparticle Physics*', Stockholm, 22–25 Sep 1994
- '*Beyond the Desert*', Castle Ringberg, 6–12 June 1999
- COSMO-01, Rovaniemi, 30 Aug–4 Sep 2001
- WIN'02, Canterbury, 21–26 Jan 2002
- COSMO-03, Ambleside, 24–30 Aug 2003
- '*Quantum gravity phenomenology*', Ladek Zdroj, 4–14 Feb 2004
- '*3rd International workshop on Ultra High Energy Cosmic Rays*', Leeds, 22–24 Jul 2004
- WIN'05, Delphi, 6–11 Jun 2005
- WIN'07, Kolkata, 15–20 Jan 2007
- ICGC'07, Pune, 17–21 Dec 2007
- DISCRETE'08, Valencia, 11–16 Dec 2008
- '*Radiation Matter Interaction Under Extreme Conditions*', Varanasi, 19–20 Dec 2008
- *9th Hellenic School of Elementary Particle Physics & Gravity*, 30 Aug–20 Sep 2009
- '*Dark Matter in Astrophysics & Particle Physics*', Cambridge, 2–6 Aug 2010
- *10th Hellenic School of Elementary Particle Physics & Gravity*, 29 Aug–19 Sep 2010
- DISCRETE'10, Rome, 6–11 Dec 2010
- '*Primordial Features and Non-Gaussianities*', Allahabad, 14–18 Dec 2010
- TAUP 2011, Munich, 5–9 Sep 2011
- *Lepton-Photon Conference*, Mumbai, 22–27 Aug 2011
- *11th Hellenic School of Elementary Particle Physics & Gravity*, Corfu, 4–18 Sep 2011
- *5th Workshop on Very Large Volume Neutrinos Telescopes*, Erlangen, 12–14 Oct 2011
- XII Workshop on High Energy Physics Phenomenology, 2–15 Jan 2012
- COSGRAV12: *International Conference on Modern Perspectives of Cosmology & Gravitation*, 7–11 Feb 2012
- ICHEP2012: *36th International Conf. on High Energy Physics*, Melbourne, 4–11 Jul, 2012
- *Darkattack2012*, Ascona, 15–20 Jul 2012
- *12th Hellenic School of Elementary Particle Physics & Gravity*, Corfu, 8–17 Sep 2012

Participation in Experiments:

- > BEBC WA66 Beam Dump Collaboration (Data analysis 1985)
- > *Pierre Auger Observatory* (Institutional Representative, 2003–)
- > *IceCube* (Collaboration Board Member, 2004–)
- > *Cherenkov telescope Array* (Collaboration Member, 2010–)

Research Grants Obtained:

1. SERC Starter Research Grant ('*Cosmological Probes of Physics Beyond the SM*')
PI, 1993–98 [GR/H90162]

2. EU Third Framework Programme (*'Theoretical Astroparticle'* network)
(Annecy + Barcelona, Copenhagen, Geneva, Gran Sasso, Munich, Oxford, Paris, Stockholm)
UK Scientist-in-Charge, 1993–97 [CHRX-CT93-0120]
3. EU 4th Framework Programme (*'Beyond the Standard Model'* TMR network)
(Paris + Bonn, Geneva, Lisbon, Madrid, Oxford, Pisa, Thessaloniki, Trieste, Valencia)
Co-I with G Ross (PI) *et al*, 1996–00 [FMRX-CT96-0090]
4. British Council 'Acciones Integradas' Programme (*'Large-scale Structure'* network)
(Barcelona, Cambridge, Durham, Oxford)
Co-I with G Efstathiou (PI) *et al*, 1997–98
5. PPARC Rolling Grant (*'Theoretical Studies of Elementary Particles'*)
Co-I with G Ross (PI) *et al*, 1999–03 [PPA/G/O/2000/00469];
6. PPARC Special Program Grant (*'Neutrino Mass'*)
Co-I with G Ross (PI), 2000–02 [PPA/G/S/1998/00561]
7. EU 5th Framework Programme (Marie Curie training site *'Particle Astrophysics'*)
Co-I with J Binney and J Silk (PI), 2000–03
8. EU 5th Framework Programme (*'Physics Across the Present Energy Frontier'* TMR network)
(Paris + Bonn, Geneva, Lisbon, Madrid, Oxford, Pisa, Thessaloniki, Trieste, Valencia)
Co-I with G Ross (PI) *et al*, 2000–04 [HPRN-CT-2000-00148]
9. EU 5th Framework Programme (*'Supersymmetry and the Early Universe'* TMR network)
Network Coordinator, 2000–04 [HPRN-CT-2000-00152]
10. Leverhulme Foundation (*'Dark Matter'*)
Co-I with J Binney and J Silk (PI), 2000–05 [F/08776A]
11. EU Marie Curie fellowship (*'Cosmic Ray Probe of Physics beyond the SM'*)
Scientist-in charge (awarded to R Toldra), 2000–02 [MCFI-1999-00465]
12. Joint Research Equipment Initiative (*'Beowulf Supercomputer'*)
Co-I with J Silk (PI) *et al*, 2000–05
13. EU Marie Curie fellowship (*'Non-Baryonic Dark Matter'*)
Scientist-in charge (awarded to F Ferrer), 2001–03 [MCFI-2001-00645]
14. PPARC Rolling Grant (*'Theoretical Studies of Elementary Particles'*)
Co-I with G Ross (PI) *et al*, 2003–08 [PPA/G/O/2002/00479]
15. PPARC Special Program Grant (*'Neutrino Physics'*)
Co-I with G Ross (PI), 2004–06 [PPA/G/S/2003/00138]
16. PPARC Research Grant (*'Operation of the Pierre Auger Observatory . . .'*)
Co-applicant with A Watson (PI) *et al*, 2004–07 [PPA/G/S/2003/00073]
17. PPARC Senior Fellowship (*'Auger & IceCube: Probes of the high energy universe'*)
PI, 2006–09 [PPA/C506205/1]
18. EU 6th Framework Programme Marie Curie RTN (*'The Origin of the Universe'*)
Network Coordinator, 2006–10 [MRTN-CT-2006-035863]
19. John Fell Fund *Strengthening Oxford-India Research Links in Theoretical Physical Sciences*)
PI (with J. Cardy *et al*), 2006–09
20. STFC Research Grant (*'UHE cosmic ray research with the Pierre Auger Observatory'*)
PI, 2008–11 [PPA/E007007/1]
21. PPARC Rolling Grant (*'Theoretical Studies of Elementary Particles'*)
Co-I with G Ross (PI) *et al*, 2008–11 [ST/G000492/1]
22. UKIERI grant (*'Interdisciplinary Oxford-India Research Network in Theoretical Physics'*)
Co-I (with J. Cardy *et al*), 2008–11
23. STFC Rolling Grant (*'Theoretical Studies of Elementary Particles'*)
PI, 2011–14
24. IPPP Associateship (*'Phenomenology of Dark Matter'*)
PI, 2011–12

Participation in Networks:

- > Scientist-in-Charge @ Oxford, EU network on '*Theoretical Astroparticle Physics*', 1993–97 (Annecy + Barcelona, Copenhagen, Geneva, Gran Sasso, Munich, Oxford, Paris, Stockholm)
- > Member, [UK Cosmology Network](#), 1995–
- > Member, Oxford node of EU network on '*Beyond the Standard Model*', 1996–00 (Paris + Bonn, Geneva, Lisbon, Madrid, Oxford, Pisa, Thessaloniki, Trieste, Valencia)
- > Co-ordinator, EU network on '*Supersymmetry and the Early Universe*', 2000–04 (Oxford/Lancaster/King's College + Bonn, Geneva, Helsinki, Ioannina/Thessaloniki, Madrid/Barcelona/Granada, Orsay/Annecy/Marseilles, Trieste, Warsaw)
- > Member, Oxford node of [European Network of Theoretical Astroparticle Physics](#), 2004–
- > Member, [UK Neutrino Network](#), 2004–
- > Member, Oxford node of EU network on '*Quest for Unification*', 2004–08 (Paris + Salonicki, Lisbon, Madrid, Bonn, Oxford, Pisa, Trieste, Valencia, Geneva)
- > Co-ordinator, EU network on '*Origin of the Universe*', 2006–10 (Oxford + Lancaster, King's College London, Annecy, Barcelona, Bonn, Copenhagen, Geneva, Helsinki, Ioannina, Munich, Padova, Paris, Seoul, Warsaw)
- > Oxford representative, UK-India Education & Research Initiative (UKIERI) Network on '*Neutrino & the Fundamental Laws of Nature*', 2007–10
- > Member, UK-India Education & Research Initiative (UKIERI) Network on '*Theoretical Physical Sciences*', 2008–11
- > Member, Oxford node of EU network on '*Unification in the LHC era*', 2009– (Paris + Salonicki, Lisbon, Madrid, Bonn, Oxford, Pisa, Trieste, Valencia, Geneva)
- > Co-ordinator, [Oxford-India network on Theoretical Physical Sciences](#), 2006–

Awards & External Appointments:

- > Indian [National Science Talent Search](#) Scholarship, 1969–78
- > Advanced Fellowship, UK Particle Physics & Astronomy Research Council, 1992–97
- > Maxwell Visiting Fellow, [King's College, London](#), 2000–05
- > George Marx Memorial Lecturer, Balatonfűrd, 2003
- > Adjunct Professor, [Tata Institute of Fundamental Research](#), Mumbai, 2006–09
- > Senior Fellowship, UK [Science & Technology Facilities Council](#), 2006–09
- > Adjunct Professor, [Saha Institute of Nuclear Physics](#), Kolkata, 2008–
- > Scientific Associate, [Discovery Center, Niels Bohr Institute](#), Copenhagen, 2010–15
- > Associate, [Institute of Particle Physics Phenomenology](#), Durham, 2011–12

Teaching:

- > Undergraduate lectures: *Classical Mechanics*, *Special Relativity*, *Particle Physics*
- > Graduate lectures & classes: *Astroparticle Physics*, *Physical Cosmology*, *The Early Universe*,
- > M.Phys. projects: *Cosmic Microwave Background*, *Dark Matter*, *Primordial Nucleosynthesis*
- > B.A. projects: *The Origin of Cosmic Rays*, *Tests of Lorentz Invariance*
- > Organisation of seminars: 1) *Particle Phenomenology Forum* 2) *Theoretical Physics Seminars* 3) *Theoretical Particle Physics Seminars* 4) *Theoretical Astrophysics Seminars*
- > Undergraduate tutoring: *Mathematics*, *Special Relativity*, *Particle & Nuclear Physics*

Public Understanding of Science

I have worked (1988-89) with 'Eklavya', a NGO based in Bhopal, India which runs a state-funded science teaching programme in several hundred rural municipal schools and is also concerned with a variety of science-related social and environmental issues. I have also engaged in the following science popularisation activities in the UK:

- > Department of Physics, Oxford:
 - Service on 'Publicity Committee' (1995–96)
 - Participation in Science, Engineering & Technology (SET) Weeks, Open Days
 - Member of Assessment Panel, Undergraduate Speaking Competition (2001–04)
- > Department for Continuing Education, Rewley House, University of Oxford:
 - Summer School course on '*Blowing up the universe*', 15–22 Jul 1995
 - Day School talk on '*Cosmic antimatter*', 23 Jan 1999
 - Summer School course on '*Constructing the Universe*', 24–31 Jul 1999
- > Consultant to BBC science programme makers on several occasions
- > Assisted the [Royal Institution, London](#) to organise topical exhibition
- > Filmed interview for new [Space Galleries at Royal Greenwich Observatory](#) (Dec 2007)
- > Public debate on '*The fate of the universe: Does dark energy exist?*', Imperial College, London, July 2009
- > Talks:
 - '*Why do science?*', Kingsway Camden's College, London, 10 May 1993
 - '*A magical mystery tour of the universe*'
 - St Phillip & James Primary School, Oxford, 9 Oct 1997
 - St Barnabas Primary School, Oxford, 14 Jun 2004
 - '*Why is the sky dark at night?*'
 - SET'95 Public Lecture, Oxford, 17 Mar 1995
 - Cherwell School, Oxford, 26 Mar 1996
 - SET'97 'Frontier Physics for Teachers', Cosener's House, Abingdon, 15 Mar 1997
 - Oxford Space & Astronomical Society, Oxford, 9 Feb 1998
 - '*Seeing the edge of the universe*'
 - Linacre College Seminar, Oxford, 12 Oct 1999
 - 'Oxford Festival of Science' Programme, Peers School, Oxford, 26 Jan 2000
 - Charterhouse School, Godalming, 6 Mar 2001
 - IOP Lecture, Shrewsbury School, 28 Sep 2001
 - New College 'Discovery Evening', Oxford, 15 Nov 2001
 - St Edward's School, Oxford, 13 Mar 2002
 - Taunton School, 10 May 2002
 - Georgia Tech Summer School, Oxford, 17 Jul 2002
 - Linacre Lecture at King's School, Canterbury, 18 Sep 2003
 - National AimHigher Masterclass for Sixth Form students, Oxford, 6 Dec 2004
 - Jadavpur University, Kolkata, 5 Jan 2005
 - British Council, Kolkata, 7 Jan 2005
 - Dudley Residential Masterclass, Oxford, 21 Mar 2005
 - Open Day talk, Department of Physics, Oxford, 30 Jun 2005
 - Headington School, Oxford, 28 Nov 2005
 - Admissions talk, Department of Physics, Oxford, 13 Dec 2005
 - AVM School Bandra, Mumbai, 20 Dec 2006
 - Cherwell School, Oxford, 17 Jan 2007
 - Physics Olympiad InfoSys lecture, Homi Bhabha Centre for Science Education, Mumbai, 22 Dec 2008
 - [International Year of Astronomy lecture](#), Green Templeton College, Oxford, 3 Mar 2009
 - [Chipping Norton Amateur Astronomical Society](#), 21 Mar 2011
 - '*The road to quantum gravity*'
 - 'Frontier Physics for Teachers' Workshop, Cosener's House, Abingdon, 4 Mar 2000
 - 'Oxford Access Scheme' Summer School, Dept of Physics, Oxford, 23 Aug 2000

- Georgia Tech Summer School, Oxford, 9 Jul 2001
- IOP 'Young Physicist's Conference', Dept of Physics, Oxford, 25 Nov 2001
- Linacre College Seminar, Oxford, 12 Feb 2002
- A K Raychoudhury Symposium, Scottish Church College, Kolkata, 5 Jan 2005
- Oxford University Science Society, 26 Apr 2012
- *'Discovering brane-world'*
 - Meeting of Heads of Physics, Rugby Group, Cheltenham College, 24 Feb 2001
 - 'Oxford Access Scheme' Summer School, Dept of Physics, Oxford, 22 Aug 2001
- *'Cosmology in wonderland'*, IOP 'Physics Update' Meeting, Oxford, 10 Dec 2004
- *'Dark matter vs. modified gravity'*, [Oxford Space & Astronomical Society](#), 1 Nov 2010
- *'Darkness visible: the search for the missing mass of the universe'*
 - [Public talk at Lepton Photon 2011](#), TIFR, Mumbai, 27 Aug 2011
 - Larsen & Toubro "GuruSpeak" Forum, Mumbai, 30 Aug 2011
 - Cambridge University Scientific Society, 11 Oct 2011
- > Articles & letters in scientific/academic magazines:
 - *'Lifetime significance'*, Physics World, 1987
 - *'Shadow of a star: the neutrino story of Supernova 1987a'*, THES, Sep 1997 (book review)
 - *'Could the end be in sight for high energy cosmic rays?'*, Physics World, Sep 2002, p.23
 - *'The solution to Olbers' paradox'*, Physics World, Oct 2002, p.17
 - *'Does dark energy really exist?'*, Physics World, Jul 2004
 - *'Lambda marks the spot: the biggest problem in theoretical physics'*, Plus Magazine, Jun 2009
- > My work was reported on in:
 - Astronomy Today: *'Quantum Gravity - revealed by gamma ray bursts?'*, 2001
 - Bild der Wissenschaft: *'Ist die dunkle energie eine illusion?'*, June 2006, p.54
 - CERN Courier: *'Neutrino Oscillations NOW'*, Nov 1998, p.17; *'Directions beyond the Standard Model'*, Mar 1999, p.23; *'Relic neutrinos, a challenge for the next millennium'*, Mar 1999, p.25; *'UK theorists investigate new trends'*, Mar 2000, p.6; *'Testing models for quantum gravity'*, Sep 2002
 - Guardian: *'Faster than light particles found, claim scientists'*, Sep 2011
 - Nature: *'Cosmic rays without end'*, 3 Sep 1998; *'Quantum gravity: Testing time for theories'*, 18 Mar 1999; *'Relativity: Special treatment'*, 4 July 2002; *'Quantum gravity: an astrophysical constraint'*, 28 Aug 2003; *'Physicists question model of the universe'*, 12 Apr 2007; *'Bursting dark energy's bubble'*, 2 Nov 2007
 - New Scientist: *'Mystery of gravity wave shakes astronomers'*, 24 Mar 1988, p.24; *'Supernova sheds light on cold dark matter'* 18 Feb 1995, p.17; *'Has SUSY shown her shadowy face'*, 30 Mar 1996, p.15; *'In the beginning'*, 25 Apr 1998, p.7; *'The crypton factor'*, 27 Jun 1998, p.16; *'Quantum foam'*, 19 Jun 1999, p.28 (also *'Quantum players'*, 24 Jul); *'Is dark energy a mirage?'*, 6 Dec 2003, p.10; *'Particle physicist takes on Newton and Einstein'*, 28 Apr 2007; *'Dark energy may just be a cosmic illusion'*, 7 Mar 2008; *'Finally, a MAGIC test for string theory?'*, 8 Sep 2007; *'Moon used as giant particle detector'*, 5 Aug 2009; *'Heart of darkness could explain Sun mysteries'*, 14 Jul 2010; *'Dark energy is not an illusion after all'*, 16 Mar 2011
 - Physics World: *'Gamma-ray bursts could test quantum gravity'*, Jun 1998; *'Particle physics: the next generation'*, Dec 1999, p.43; *'The new universe around the next corner'*, Dec 1999, p.79; *'Quantum gravity's new phenomenon'*, Mar 2002, p.9; *'Quantum gravity phenomenology'*, Nov 2003, p.43; *'Asking the big questions in London'*, Jul 2009
 - Pour La Science: *'Désintégration de cryptons'*, Oct 1998, p.32
 - Science: *'Java applet lets readers bite into research'*, 2 Jul 1999, p.34
 - Science News: *'A little mass goes a long way'*, Jan 1999, p.76
 - Science Week: *'Gamma ray bursts: tests of quantum gravity'*, 24 Jul 1998
 - Scientific American: *'String instruments'*, Oct 1998
 - Sky & Telescope: *'Ultrahigh-energy cosmic rays'*, Mar 2003
 - Wired: *'Dark matter may be building up inside the Sun'*, 9 Jul 2010
 - The Independent: *'Dark energy: A cosmic mirage?'*, 7 Jan 2004

Publications:

Refereed Journals:

- [1] [Detection of relativistic iron nuclei in the plastic track detector CR-39](#)
Nuclear Instruments & Methods 163 (1979) 183–187
(with S. Biswas, N. Durgaprasad, P.J. Kajarekar & V.S. Venkatavaradan)
- [2] [A lower Limit to the magnetic Field in Cassiopeia-A*](#)
Monthly Notices of the Royal Astronomical Society 191 (1980) 855–861
(with R. Cowsik)
- [3] [Does the galactic synchrotron background originate in old supernova remnants?*](#)
Monthly Notices of the Royal Astronomical Society 199 (1982) 97–108
- [4] [The evolution of supernova remnants as radio sources*](#)
Monthly Notices of the Royal Astronomical Society 207 (1984) 745–775; [erratum](#) 209, 719 (topcite 50+)¹
(with R. Cowsik)
- [5] [Astrophysical consequences of \$n - \bar{n}\$ oscillations*](#)
Nature 309 (1984) 727
- [6] [Cosmological & experimental constraints on the tau neutrino*](#)
Physics Letters 148B (1984) 347–354 (topcite 50+)²
(with A.M. Cooper)
- [7] [The cosmology of decaying gravitinos*](#)
Nuclear Physics B259 (1985) 175–188 (topcite 250+)
(with J. Ellis & D.V. Nanopoulos)
- [8] [Bounds on light gluinos from the BEBC beam dump experiment*](#)
Physics Letters 160B (1985) 212–216 (topcite 50+)
(with the WA66 collaboration)
- [9] [Search for heavy neutrino decays in the BEBC beam dump experiment*](#)
Physics Letters 160B (1985) 207–211 (topcite 50+)
(with the WA66 collaboration)
- [10] [Primordial nucleosynthesis, additional neutrinos & neutral currents from the superstring*](#)
Physics Letters 167B (1986) 457–463 (topcite 100+)
(with J. Ellis, K. Enqvist & D.V. Nanopoulos)
- [11] [Neutron oscillations & the primordial magnetic field*](#)
Astrophysics Letters & Communications 27 (1989) 293–297
- [12] [Low mass photinos & supernova 1987A*](#)
Physics Letters 215B (1988) 404–410
(with J. Ellis, K.A. Olive & D.W. Sciama)
- [13] [Astrophysical constraints on massive, unstable neutral relic particles*](#)
Nuclear Physics B373 (1992) 399–437 (topcite 250+)
(with J. Ellis, G.B. Gelmini, J. Lopez & D.V. Nanopoulos)
- [14] [On the implications of a 17-keV neutrino*](#)
Physics Letters 260B (1991) 381–388
(with A. Hime, R.J.N. Phillips & G.G. Ross)
- [15] [Bound on the tau neutrino magnetic moment from the BEBC beam dump experiment](#)
Physics Letters B280 (1992) 153–158 (topcite 50+)
(with A.M. Cooper-Sarkar, J. Guy, W. Venus, P.O. Hulth & K. Hultqvist)
- [16] [Cosmic neutrinos from unstable relic particles*](#)
Nuclear Physics B392 (1993) 111–133 [hep-ph/9209236] (topcite 50+)
(with P. Gondolo & G.B. Gelmini)

- [17] [Neutralino dark matter in a class of unified theories*](#)
Nuclear Physics B392 (1993) 83–110 [hep-ph/9209292]
(with S.A. Abel & I.B. Whittingham)
- [18] [Cosmological constraints on perturbative supersymmetry breaking*](#)
Physics Letters B342 (1995) 40–46 [hep-ph/9409350]
(with S.A. Abel)
- [19] [Remarks on the KARMEN anomaly*](#)
Physics Letters B352 (1995) 365–371; erratum B356, 617 [hep-ph/9503295] (topcite 50+)
(with V. Barger & R.J.N Phillips)
- [20] [Successful supersymmetric inflation*](#)
Nuclear Physics B461 (1996) 597–623 [hep-ph/9506283] (topcite 50+)
(with G.G. Ross)
- [21] [On the cosmological domain wall problem for the minimally extended supersymmetric standard model*](#)
Nuclear Physics B454 (1995) 663–681 [hep-ph/9506359] (topcite 100+)
(with S.A. Abel & P.L. White)
- [22] [A supersymmetric resolution of the KARMEN anomaly*](#)
Physics Letters B374 (1996) 87–92 [hep-ph/9511357]
(with D. Choudhury)
- [23] [Big bang nucleosynthesis & physics beyond the standard model*](#)
Reports on Progress in Physics 59 (1996) 1493–1610 [hep-ph/9602260] (topcite 250+)
- [24] [No crisis for big bang nucleosynthesis*](#)
Physical Review D54 (1996) R3681–R3685 [astro-ph/9603045] (topcite 50+)
(with P.J. Kernan)
- [25] [Nucleosynthesis bounds on a time-varying cosmological “constant”*](#)
Astroparticle Physics 6 (1997) 197–203 [astro-ph/9605055]
(with M. Birkel)
- [26] [Evading the cosmological domain wall problem*](#)
Physical Review D55 (1997) 5129–5135 [hep-ph/9608319]
(with S. Larsson & P.L. White)
- [27] [Natural supergravity inflation*](#)
Physics Letters B391(1997) 271–280 [hep-ph/9608336]
(with J.A. Adams & G.G. Ross)
- [28] [Multiple inflation*](#)
Nuclear Physics B503 (1997) 405–425 [hep-ph/9704286] (topcite 100+)
(with J.A. Adams & G.G. Ross)
- [29] [Ruling out a critical density baryonic universe*](#)
Physics Letters B408 (1997) 59–68 [hep-ph/9705331]
(with M. Birkel)
- [30] [Tests of quantum gravity from observations of gamma-ray bursts*](#)
Nature 393 (1998) 763–765 [hep-ph/9712103] (topcite 500+)
(with G. Amelino-Camelia, J. Ellis, N.E. Mavromatos & D.V. Nanopoulos)
- [31] [Quantifying uncertainties in primordial nucleosynthesis without Monte Carlo simulations*](#)
Physical Review D 58 (1998) 063506 [astro-ph/9803177] (topcite 50+)
(with G. Fiorentini, E. Lisi & F.L. Villante)
- [32] [Extremely high energy cosmic rays from relic particle decays*](#)
Astroparticle Physics 9 (1998) 297–309 [hep-ph/9804285] (topcite 100+)
(with M. Birkel)
- [33] [CMB anisotropy in the decaying neutrino cosmology*](#)
Monthly Notices of the Royal Astronomical Society 301 (1998) 210–214 [astro-ph/9805108]
(with J.A. Adams & D.W. Sciama)

- [34] [Scale of \$SU\(2\)_R\$ symmetry breaking & leptogenesis*](#)
Physics Letters B 458 (1999) 73–78 [hep-ph/9812276]
(with E. Ma & U. Sarkar)
- [35] [Big bang nucleosynthesis limit on \$N_\nu\$ *](#)
Physical Review D 59 (1999) 123520 [hep-ph/9901404] (topcite 100+)
(with E. Lisi & F. Villante)
- [36] [Implementing quadratic supergravity inflation*](#)
Physics Letters B 469 (1999) 46–54 [hep-ph/9908380]
(with G. German & G.G. Ross)
- [37] [A supersymmetric solution to the KARMEN anomaly*](#)
Physical Review D61 (2000) 095009 [hep-ph/9911365]
(with D. Choudhury, H. Dreiner & P. Richardson)
- [38] [Thermalisation after inflation*](#)
Journal of High Energy Physics 11 (2000) 012 [hep-ph/0009078]
(with S. Davidson)
- [39] [On the APM power spectrum & CMB anisotropy: Evidence for a phase transition during inflation*](#)
Monthly Notices of the Royal Astronomical Society 324 (2001) 977–987 [astro-ph/0011398] (topcite 50+)
(with J. Barriga, E. Gaztañaga & M. Santos)
- [40] [The anisotropy of the ultra-high energy cosmic rays*](#)
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[1 May 2012]