

Born 12th September 1953, Ichapur, India

Secondary education at the Central School, Ambarnath, 1963–69;  
All India Higher Secondary School Examination Certificate, 1969;  
Awarded [National Science Talent Scholarship](#), 1969–78

Undergraduate 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;

Research Associate in Cosmic Rays Group, 1979–84; Ph.D. in Physics, [University of Bombay](#), 1982

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

Research Associate, [Theory Division, CERN, Geneva](#), 1984–85

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

Research Associate, [HEP Theory Group, Rutherford Appleton Laboratory \(RAL\), 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; Advanced Fellow, [Particle Physics & Astronomy Research Council](#), 1992–97; Research Fellow, [Wolfson College](#), 1993–97; Lecturer, [Department of Physics](#), 1997–98; Tutor in Physics, [Pembroke College, Oxford](#), 1997–98

**Present position:** University Lecturer and Fellow of [Linacre College, Oxford](#) 1998–; Reader 2000; Professor 2006–; Senior Fellow, [Science & Technology Facilities Council](#) 2006–09; Head, [Particle Theory Group](#) 2011–; Niels Bohr Professor, [Niels Bohr Institute, University of Copenhagen](#) 2013–

## Honours & Awards:

- ▷ [George Marx Memorial Lecturer](#), Balatonfürd, 2003
- ▷ [IUPAP-TIFR Homi Bhabha Medal and Prize](#), 2017

## Academic Service:

- Member (Astrophysics & Cosmology section), [Particle Data Group](#), 2001–
- [Oxford University](#): Joint Committee on Physics & Philosophy, 2005–07 (Chair 2006–07); Glasstone Fellowships Committee 2008–12 (Chair 2011–12); India Strategy Working Group, 2006–15
- Steering Committee, [Astroparticle Physics Group, Institute of Physics UK](#), 2006–08
- Chair, Astroparticle Physics Panel, [STFC Programmatic Review](#), 2008
- Peer Review Committee, [Astroparticle Physics European Coordination \(ApPEC\)](#), 2005–14
- Science Vision Working Group (Panel A), [ASTRONET](#), 2006–08
- Astroparticle Physics European Research Area Network ([ASPERA](#)): Working Groups on High energy cosmic rays & neutrinos, 2007–09; Evaluation Committee, 2009; Science Advisory Committee, 2010–12
- [Agence d’Evaluation de la Recherche et de l’Enseignement Supérieur](#) Review Panel, 2005, 2009
- International Peer Review Panel, [Danish Council for Independent Research](#), 2010–12
- International Advisory Board, [Helmholtz Alliance on Astroparticle Physics](#), 2012–17
- Scientific & Technical Advisory Committee, [KM3NeT](#), 2013–
- Editorial Board, [European Physical Journal C](#), 2012–15; [Pramana: Journal of Physics](#), 2013–
- International Advisory Board, [Sant Cugat Forum on Astrophysics](#), 2012–
- Advisory Board, [Gruber Cosmology Prize](#), 2014–
- IUPAP Working Group 10: [AstroParticle Physics International Committee \(APPIC\)](#), 2014–
- Scientific Advisory Panel, [Institute of Physics, Universiteit Van Amsterdam](#), 2016–



**Research Experience:** 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, and in seeking a physical understanding of dark matter and dark energy.

**Cosmic Rays & High Energy Astrophysics:** Our experimental cosmic ray studies using plastic track detectors flown on balloons and *SKYLAB* showed that heavy nuclei in low energy cosmic rays are not fully ionised, implying a relatively local (Solar System) origin [314]. To investigate this further we designed an experiment (*Anuradha*) flown on *SPACELAB III*, which had a rotating detector to provide time resolved flux measurements, using the Earth’s magnetic field as a momentum filter.

Moving to theoretical studies we investigated cosmic ray acceleration by plasma turbulence and the non-thermal radiation which probes such environments. We combined radio, X-ray and  $\gamma$ -ray data on the young supernova remnant (SNR) *Cassiopeia A* to demonstrate that the magnetic field in the radio emitting region has been significantly amplified over the compressed interstellar field [2]. Such field amplification is essential for efficient acceleration of cosmic rays by SNR shock waves to the high energies observed. We also showed that 2<sup>nd</sup>-order Fermi acceleration by plasma turbulence generated through the deceleration of the supernova blast wave naturally yields the observed power-law (slightly *convex*) electron spectrum, and explains the rapid rise in synchrotron luminosity (accompanied by spectral flattening) of young SNRs entering the Sedov-Taylor phase [4]. Our analytic solution to the transport equation describing diffusion and convection in momentum space explained the temporal and spectral evolution of the radio emission from *Cassiopeia A*.

I noted that old SNRs in the radiative phase 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 modest magnetic field values inferred from Faraday rotation with the higher values inferred from the synchrotron luminosity. The closest of these stand out as the ‘radio loops’ which extend to high galactic latitudes and we showed that the angular power spectrum of the galactic emission is well matched by the contribution on  $\sim (1 - 10)^0$  scales from  $\mathcal{O}(10^4)$  such old SNRs [183]. We discovered that one of these, Loop I, is in fact visible in supposedly ‘foreground-cleaned’ maps of the cosmic microwave background (CMB), with its anomalous microwave emission possibly arising from magnetised dust grains [205]. Part of it crosses the sky region from which the BICEP2 experiment recently detected ‘*B*-mode’ polarisation, which was interpreted as due to gravitational waves from inflation but subsequently shown by the *Planck* satellite to arise from dust emission.

A nearby SNR may also be responsible for the positron excess in cosmic rays seen by the *PAMELA* satellite, later confirmed by AMS-02 on the Space Station, which has been widely speculated to be due to dark matter annihilation or decay. The positron secondaries created near the shock wave will themselves be accelerated and naturally acquire a harder spectrum than the primary electrons. By fitting to the  $e^- + e^+$  spectrum measured by the *Fermi* satellite, we were able to pick out the most plausible SNR source configuration by doing Monte Carlo simulations [96]. Such nearby SNRs would have a  $\gamma$ -ray brightness consistent with the unidentified extended sources seen by *MILAGRO* and should be detectable by *IceCube* in TeV energy neutrinos. As a corollary B/C and  $\bar{p}/p$  should also start flattening (or even rising) with energy [91, 203] — this is currently being checked by AMS-02 to pin down this astrophysical background to signals of new physics.

Another context in which 2<sup>nd</sup>-order Fermi acceleration of electrons is important is the  $\gamma$ -ray emission from the ‘Fermi bubbles’ — the giant bi-lobar structure discovered in the *Fermi* map of the Galactic Centre region. We have shown that inverse-Compton scattering of starlight and CMB photons by electrons fits the spectrum and morphology of the bubbles rather well, and that the electrons can be accelerated on the necessary short time scale by plasma turbulence behind the shocks [134].

I was a member of the *Pierre Auger Observatory* [94, 119, 142, 164] which has established the suppression of the energy spectrum of ultra-high energy cosmic rays at around the ‘GZK cutoff’ expected for primary protons due to photopion production on the CMB [79, 102] and a weak correlation between their arrival directions and nearby active galactic nuclei [72, 76]. I am also a member of *IceCube* [252] which made the first observation of high energy neutrinos of cosmic origin [185, 193, 206, 216, 227]. Atmospheric neutrino oscillations have also been detected [188, 213, 242, 247] and open up the possibility of measuring the neutrino mass hierarchy with the *PINGU* infill [307, 310]. My main contribution to

these experiments has been to provide state-of-the-art theoretical and phenomenological inputs for the science analyses. For example searches for ultrahigh energy neutrinos require knowledge of their deep inelastic scattering cross-section which we have computed using the latest parton distribution functions measured at HERA [70, 138]. Another key target of *Auger* and *IceCube* is the ‘cosmogenic’ neutrino flux which we have computed by analysing the intergalactic propagation of UHE cosmic protons, and imposing the constraint from *Fermi* on the concomitant  $\gamma$ -ray background [109]. Motivated by the observation that the chemical composition is getting heavier at the highest energies, we studied the intergalactic propagation of UHE heavy nuclei and showed that the cosmogenic neutrino flux is then reduced substantially [50, 61, 69, 77]. I joined the *Cherenkov Telescope Array* collaboration [303, 305] and participated in defining its science requirements and assessing the ‘Key Science Projects’, as well as co-editing the science case for the measurements to be performed [312].

**Particle Physics & the Early Universe:** My work has developed and refined the constraints on fundamental physics coming from cosmology and astrophysics. All particles, known or as yet undiscovered, would have been created in the early universe; analysis of their possible effects on the CMB and the light element abundances from Big Bang nucleosynthesis (BBN), 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 the Sun and supernovae. Such arguments have provided very useful guidance on physics beyond the Standard  $SU(3) \otimes SU(2) \otimes U(1)$  Model of particle physics [23].

By combining cosmological constraints on an unstable tau neutrino with laboratory bounds on leptonic mixing, we demonstrated that the  $\nu_\tau$  must be stable against weak decay and hence lighter than  $2m_e$  [6]. With the subsequent discovery of large-angle neutrino mixing, much stronger mass bounds follow, but these arguments remain relevant to other hypothetical neutral leptons e.g. ‘sterile’ neutrinos. We also calculated the ‘thermalisation redshift’ above which a large electromagnetic energy release in the early universe (e.g. from decaying  $\nu_\tau$ s) would be instantly converted into blackbody radiation by radiative Compton scattering, leaving no (Bose-Einstein) distortion in the observed spectrum. We were the first to show that even tiny releases of hydrogen ionising radiation would broaden the last scattering surface and noticeably damp the (then) just discovered ‘acoustic peaks’ in the CMB angular power spectrum [33] — this has proven to be a stringent constraint on late-time annihilations of relic particles, enabling precision data from the *Planck* satellite to rule out such annihilations as the source of the *PAMELA/AMS-02* anomaly

The bounds on leptonic mixing used above came from a search for heavy neutrinos using the *Big European Bubble Chamber* in the WA66 ‘beam dump’ in which I participated [9]. When monojet events seen by the *UA1* experiment were interpreted as due to a light gluino, we proposed a search in WA66 and ruled them out from the absence of any excess of neutral current-like events [8]. We also set a stringent bound on the magnetic moment of tau neutrinos.

We showed that the thermal production of massive gravitinos can be disastrous for cosmology, implying a constraint on the temperature to which the universe reheated at the end of inflation [7]. The most restrictive bound comes from consideration of the potential overproduction of D and  $^3\text{He}$  through the photodisintegration of  $^4\text{He}$  by the radiation cascade triggered in the plasma by high energy photons from gravitino decays. This implies that the baryon asymmetry cannot have been created at the GUT scale and has motivated many theoretical attempts to generate it by alternative means such as ‘leptogenesis’ which is linked to neutrino mass [34]. In subsequent work we further refined these bounds and derived new constraints on high energy neutrinos and cosmic rays produced through the decay of metastable relic particles, which have ruled them out as dark matter [13].

Such arguments have wide application, e.g. the Next-to-Minimal-Supersymmetric Standard Model (NMSSM) which addresses the ‘ $\mu$  problem’ due to the mixing of the two Higgs doublets in the MSSM by introducing an additional singlet, is *inconsistent* with cosmology [21]. Unacceptable domain walls form at electroweak symmetry breaking due to the underlying  $Z_3$  symmetry — the wall network can decay through non-renormalisable terms that violate the  $Z_3$ , but these in turn induce tadpole divergences which destabilise the hierarchy and reintroduce the hierarchy problem. Now that LHC data have shown the MSSM to be technically ‘unnatural’, the NMSSM is looking increasingly attractive, hence our result continues to be an important constraint on attempts to resuscitate weak scale supersymmetry.

We showed that in supergravity-based inflationary models, the Hubble parameter cannot exceed the gravitino mass [20]. Gravitino overproduction is avoided if the inflaton is in a hidden sector and its potential can be made sufficiently flat by making it a Goldstone mode [27]. Taking non-renormalisable terms in the potential into account, inflation can occur as low as the electroweak scale but still generate the required amplitude of density perturbations [41]. We showed that topological inflation is realised in the ‘racetrack’ model which solves the dilaton runaway problem [57]. Moreover, other scalar fields can undergo symmetry breaking phase transitions *during* inflation, introducing spectral features [28] and associated non-Gaussianity [97]. We developed a robust technique for deconvolving CMB and large-scale structure data [195] but have so far found no significant evidence [229].

We proposed that quantum gravity effects might be detectable by looking for high energy Lorentz invariance violation (LIV) through e.g. energy-dependent arrival time dispersion in cosmologically distant  $\gamma$ -ray bursts [30]. This demonstration that the Planck scale is not beyond experimental reach has generated considerable interest. Observations by Cherenkov telescopes and *Fermi* have however ruled out a LIV term  $\propto E_\gamma^2/M_{\text{Pl}}$  in the dispersion relation. However an even smaller (and theoretically more plausible) term  $\propto E_\gamma^3/M_{\text{Pl}}^2$  can decohere oscillations of cosmic neutrinos and alter their flavour ratios away from the large-angle mixing based expectation at a level detectable by *IceCube* [52].

We calculated the error correlation matrix for BBN and highlighted systematic uncertainties in inferring the primordial abundances [31], which allow an additional light neutrino (or equivalent particle) [35]. This imposes constraints on e.g. an additional  $Z'$  to which singlet neutrinos are coupled [10], on a ‘time-varying cosmological constant’ [25], on photon mixing [29] and on a light neutralino [154].

**Dark Matter & Dark Energy:** An attractive particle candidate for dark matter is the lightest supersymmetric state. We have shown that neutralinos in the NMSSM can be significantly lighter than the weak scale [17] — a possibility that has become experimentally interesting recently. 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 [16]. When ultrahigh energy cosmic rays were detected beyond the expected ‘GZK cutoff’ we proposed that these arise from the slow decays of such particles clustered in the galactic halo [32] — the observed spectrum is well matched by that expected from QCD fragmentation [43], while the expected small anisotropy in arrival directions should be detectable with forthcoming data [40]. (Even though this model is now disfavoured because the *Auger* data show that the trans-GZK flux is indeed suppressed and that high energy photons do *not* dominate over nucleons as would be expected from particle decays, these calculations remain relevant in other contexts.)

We first emphasised that the dwarf spheroidal satellite galaxies of the Milky Way are good search targets for  $\gamma$ -rays from dark matter annihilation, using dynamical arguments to infer their dark matter content [47, 133, 218]. However dark matter may have an asymmetry like baryons and *not* annihilate — we showed that accreted dark matter can then affect heat transport in the Sun and potentially solve the ‘Solar composition problem’ as well as alter Solar neutrino fluxes [104]. Such dark matter arises in models of new strong dynamics [132] and can have different couplings to protons and neutrons, thus potentially reconciling the signal seen in DAMA with upper limits from XENON [139]. However astrophysical uncertainties alone cannot make these results consistent [152]. We discussed collider probes of such new vector interactions [159]. We have studied dark matter self-interactions in colliding clusters [196] and reassessed the recent claim for a signal in A3827 [220].

The breaking of scale-invariance of primordial perturbations due to phase transitions occurring during inflation can dramatically affect cosmological parameter extraction from CMB and other data, in particular doing away with the need for dark energy [39, 46, 68, 80]. Our recent analysis of the Type Ia supernova Hubble diagram also shows that the evidence for cosmic acceleration is *marginal* [222]. Dark energy may thus be just an artifact of interpreting data in an oversimplified model framework. Moreover searches for its dynamic effects, such as the ‘late ISW effect’ using observations of stacked voids, are, we find, inconsistent with the standard  $\Lambda$ CDM cosmological model [80, 150], as is the number of merging galaxy clusters [215]. I am currently working on formalising evidence that suggests that a major revision of the current paradigm is overdue.



## Invited Talks at Conferences &amp; 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 [273]
3. UK HEP Theory X'mas Meeting, Rutherford Appleton Laboratory, Chilton, Dec 1987
4. NATO ASI: *Observational Tests of Cosmological Inflation*, Durham, Dec 1990 [274]
5. UK HEP Theory X'mas 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 [276]
15. WHEPP 96: Fourth Workshop on High Energy Physics Phenomenology, Calcutta, Jan 1996
16. DARK 96: *Dark Matter in Astro- & Particle Physics*, Heidelberg, Sep 1996 [275]
17. WIN 07: XVI Intern. Workshop on *Weak Interactions & Neutrinos*, Capri, Jun 1997 [277]
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: *Dark Matter in Astro- & Particle Physics*, Heidelberg, Jul 1998
23. NOW 98: EPS *Neutrino Oscillation Workshop*, Amsterdam, Sep 1998 [301]
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: *Particle Physics & the Early Universe*, Trieste, Oct 1999 [280]
28. Landelijk Seminarium, NIKHEF, Amsterdam, Dec 1999
29. Annual UK HEP 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. XIII Recontres des Blois: *Frontiers of the Universe*, Blois, Jun 2001 [287]

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: Intern. Europhysics Conf. on High Energy Physics, Budapest, Jul 2001 [284]
36. COSMO-01: *Particle Physics & the Early Universe*, Rovaniemi, Sep 2001 [285]
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: *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 [288]
48. ISMD 03: XXXIII International Symposium on Multiparticle Dynamics, Krakow, Sep 2003 [286]
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: *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 [290]
54. *Terrestrial and Cosmic Neutrinos, leptogenesis and Cosmology*, Benasque, Jul 2004
55. ISVHECRI 04: Intern. Symp. 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: Intern. 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*, Bhubaneswar, Jan 2006 [302]

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. *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: Intern. 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: Intern. Conf. on *Neutrino Physics & Astrophysics*, Christchurch, May 2008 [293]
87. International Conference on *Quantum Geometry & Quantum Gravity*, Nottingham, Jul 2008
88. International Conference on *Dark Energy and Dark Matter*, Lyon, Jul 2008 [295]
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. IoP 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 & Cosmology*, Mahabalipuram, Apr 2009
98. *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. *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. *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 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 astro- & particle physics, Cambridge, Aug 2010
114. *Confronting theory with observations*: UniverseNet cosmology workshop, Copenhagen, Aug 2010
115. SUSY10: *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. 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 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: 32<sup>nd</sup> 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 & 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



132. [HEP2012: Recent Developments in High Energy Physics and Cosmology](#) Ioannina, Apr 2012
133. Planck 2012: *From the Planck Scale to the Electroweak Scale*, Warsaw, May 2012
134. NORDITA Workshop on *Origin of Mass 2012*, Stockholm, Jun 2012
135. [darkattack2012](#), Ascona, Jul 2012
136. [International Symposium on Very High Energy Cosmic Ray Interactions](#), Berlin, Aug 2012
137. IAU XXVIII General Assembly: *The Highest-Energy Gamma-ray Universe*, Beijing, Aug 2012
138. Workshop on *Physics of De Sitter Space-time*, Hannover, Sep 2012
139. John Ellis Day, *Outlook in Particle Physics*, London, Oct 2012
140. [IMAPP Jubilee Colloquium](#), Nijmegen, Nov 2012
141. [Partikeldagarna](#), Stockholm, Nov 2012
142. [ASPERA ad futurum](#), Brussels, Nov 2012
143. V F Hess Centenary Symposium, Mumbai, Dec 2012
144. *Time & Matter*, Venice, Mar 2013
145. Nordic CTA Meeting, Stockholm, Mar 2013
146. 47th ESLAB Symposium: *The Universe as seen by PLANCK*, Noordwijk, Apr 2013
147. Latsis Symposium: *Nature at the Energy Frontier*, Zurich, Jun 2013
148. [KSETA Plenary Workshop](#), Bad Herrenalb, Feb 2014
149. *New Frontiers in Theoretical Physics*, Cortona, May 2014
150. [SWAPS 2014](#), Geneva, Jun 2014
151. *Frontiers of Fundamental Physics*, Marseille, Jul 2014
152. [DISCRETE 2014](#), London, Dec 2014
153. [NuPhys2014](#), London, Dec 2014
154. [LahanasFest](#), Athens, Jan 2015
155. [Measuring B-mode polarization from Greenland](#), Copenhagen, Feb 2015
156. [AMS Days at CERN: The Future of Cosmic Ray Physics](#), Geneva, Apr 2015
157. [WylerFest](#), Zurich, May 2015
158. [5th Iberian Gravitational-Wave Meeting](#), Barcelona, May 2015
159. Workshop on *Alternative matter & alternative gravity*, Heraklion, May 2015
160. [TamavakisFest](#), Ioannina, May 2015
161. [Planck 2015](#), Ioannina, May 2015
162. *2015: The Spacetime Odyssey Continues*, Stockholm, Jun 2015
163. *Current Themes in High Energy Physics & Cosmology*, Copenhagen, Aug 2015
164. [EuNPC 2015](#), Groningen, Sep 2015

165. [Sixth Quantum Universe Symposium](#), Groningen, Mar 2016
166. [APPEC Town Meeting](#), Paris, April 2016
167. [Axion-like Particles: Theory & Experiment](#), Durham, April 2016
168. [CMB Spectral Distortions](#), Bangalore, Jul 2016
169. [Relativistic astrophysics & gravitational waves](#), Copenhagen, Jul 2016
170. [Current Themes in High Energy Physics & Cosmology](#), Copenhagen, Aug 2016
171. [LHC Days in Split](#), Split, Sep 2016
172. [Danish Astroparticle Physics Meeting](#), Odense, Oct 2016
173. [Dark matter from aeV to ZeV](#), Lumley Castle, Nov 2016
174. [Landelijk Seminarium](#), NIKHEF, Mar 2017
175. [DIS 2017](#), Birmingham, Apr 2017
176. [The future of WIMP dark matter](#), Chicheley Hall, May 2017
177. [Messengers: Astroparticles and Gravitational Waves](#), Stockholm, Jul 2017
178. [DAVCo: DArk matter, neutrinos and their Connections](#), Odense, Sep 2017
179. [Galileo Institute Conference: Collider Physics & the Cosmos](#), Florence, Oct 2017

#### Invited Lectures at Schools:

1. ICTP Summer School in ‘High Energy Physics & Cosmology’, Trieste, Jul 1985 [272]
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 [279]
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 [281]

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
39. [Intern. School of Cosmic Ray Astrophysics: ‘A new era in particle astrophysics’](#), Erice, Jul 2012
40. [4th International Summer School on Astroparticle Physics](#), Nijmegen, Aug 2012
41. [Nordic Winter School on Particle Physics and Cosmology](#), Gausdal, Jan 2013
42. [International School for AstroParticle Physics \(ISAPP\) 2013](#), Djurönäset, Aug 2013
43. [Corfu Summer School on ‘The Standard Model & Beyond’](#), Sep 2013
44. [Corfu Summer School on ‘The Standard Model & Beyond’](#), Sep 2014
45. [ICTP Summer School on Particle Physics](#), Jun 2015
46. [Taller de Altas Energias](#), Benasque, Sep 2016
47. [Nordic Winter School on Particle Physics and Cosmology](#), Skeikampen, Jan 2017

D.Phil Theses Supervised:

1. [Kevin C. Benson](#), Wadham College, Oxford, 1991–93  
(Thesis: ‘*Aspects of the electroweak phase transition & baryogenesis*’)
  2. [Jennifer A. Adams](#), Magdalen College, Oxford, 1992–95  
(Thesis: ‘*Cosmological phase transitions: techniques & applications*’)
  3. [Sebastian E. Larsson](#), Christ Church College, Oxford, 1993–98  
(Thesis: ‘*Topological defects from cosmological phase transitions*’)
  4. [Michael Birkel](#), Linacre College, Oxford, 1994–97  
(Thesis: ‘*Astroparticle physics beyond the Standard Model*’)
  5. [Fermin Viniegra](#), Worcester College, Oxford, 1997–2001  
(Thesis: ‘*Reheating in inflationary cosmology*’) — with B Bassett
  6. [Mario Santos](#), Wadham College, Oxford, 1999–2003  
(Thesis: ‘*Primordial effects in the CMB*’) — with P Ferreira
  7. [David Skinner](#), Linacre College, Oxford, 1999–2003  
(Thesis: ‘*Cosmology of heterotic M-theory*’)
  8. [Paul Hunt](#), St John’s College, Oxford, 2000–06  
(Thesis: ‘*The cosmological implications of inflation*’)
  9. [Andrew Taylor](#), Linacre College, Oxford, 2003–06  
(Thesis: ‘*The intergalactic propagation of ultrahigh energy cosmic rays*’)
  10. [Francesco Riva](#), Merton College, Oxford, 2004–08  
(Thesis: ‘*Cosmological consequences of supersymmetric flat directions*’) — with J March-Russell
  11. [Joao Rosa](#), Exeter College, 2006–10  
(Thesis: ‘*Aspects of Beyond the Standard Model String Phenomenology*’) — with J March-Russell
  12. [Shaun Hotchkiss](#), Balliol College, Oxford, 2006–10  
(Thesis: ‘*Inflation: beyond the scalar fluctuation power spectrum*’)
  13. [Philipp Mertsch](#), Balliol College, Oxford, 2007–10  
(Thesis: ‘*Cosmic ray backgrounds for dark matter indirect detection*’)
  14. [Seshadri Nadathur](#), Merton College, Oxford, 2007–11  
(Thesis: ‘*Inflation, large-scale structure & inhomogeneous cosmologies*’)
  15. [Felix Kahlhoefer](#), St Catherine’s College, Oxford, 2011–14  
(Thesis: ‘*Complementarity of searches for dark matter*’)
  16. [Kyle Allison](#), Balliol College, Oxford, 2010–14  
(Thesis: ‘*The Standard Model to the Planck scale*’) — with G Ross
  17. [Jim Talbert](#), Hertford College, Oxford, 2012–16  
(Thesis: ‘*From the LHC to IceCube, a melange of particle phenomenology*’) — with G Bell
  18. [David Kraljic](#), Balliol College, Oxford, 2012–16  
(Thesis: ‘*Inhomogeneities in Cosmology*’)
  19. [Jeppe Trøst Nielsen](#), Niels Bohr Institute, Copenhagen, 2013–17  
(Thesis: ‘*Testing cosmological models*’)
- Present:
20. [Amel Durakovic](#), Niels Bohr Institute, Copenhagen, 2014–  
(working on inflation)

21. Konstantin Beyer, Merton College, Oxford, 2017–  
(working on axion plasma physics) — with G Grehori

## Refereeing

Appointments & Promotions: CERN, Geneva; Demokritos, Athens; DESY, Zeuthen; Fermilab, Batavia; HRI, Allahabad; IISER, Bhopal; IMSc, Chennai; ICTP, Trieste; IUCAA Pune; King's College, London; LAPTH, Annecy; Michigan State University; MPIK Heidelberg; National Technical University Athens; NISER, Jatni; NORDITA Stockholm; Penn State University; RRI, Bangalore, Royal Holloway, University of London; SINP Kolkata; SISSA Trieste; TIFR Mumbai; Universität Aachen; University of Athens; University of Bath; University of California, Berkeley; University of California, Los Angeles; University of Cambridge; University of Crete; Universität Dortmund; University of Durham; University of Edinburgh; University of Geneva; Universität Göttingen; Universität Hamburg; Universität Karlsruhe; University of Lancaster; University of Lyon; University of Massachusetts, Amherst; University of Montpellier 2; University of New Mexico; University of Nottingham; Universität Potsdam; University of Southampton; Universität Wuppertal; Universität Zurich

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](#); [Deutsche Forschungsgemeinschaft, Germany](#); [Engineering & Physical Sciences Research Council, UK](#); [European Commission](#); [European Research Council](#); [European Space Agency](#); [Fondazione Cariparo, Italy](#); [Fundamenteel Onderzoek der Materie, Netherlands](#); [International Centre for Theoretical Physics, Trieste](#); [Istituto Nazionale di Fisica Nucleare, Italy](#); [Leverhulme Foundation, UK](#); [Ministero dell'Istruzione, Italy](#); [Ministry of Education, Greece](#); [National Research Foundation, South Africa](#); [National Science Foundation, USA](#); [Nederlandse Organisatie voor Wetenschappelijk Onderzoek](#); [Newton Institute, Cambridge](#); [RANNIS Iceland](#); [Royal Society of New Zealand](#); [The Royal Society, UK](#); [Science & Technology Facilities Council, UK](#); [Swiss National Science Foundation](#)

Book proposals: [Cambridge University Press](#), [Oxford University Press](#)

Journals: Astronomy & Astrophysics, Astrophysical Journal, Astroparticle Physics, Classical & Quantum Gravity, Computer Physics Communications, European Physical Journal C, Europhysics Letters, Journal of Cosmology & Astroparticle Physics, Journal of High Energy Physics, 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

## Organisation of Conferences, Schools & Workshops:

### ▷ Main Organiser:

- UK Theoretical Cosmology Network meeting, Oxford, 15 May 1996, 26 Mar 1997, 20 May 1998
- EU Research & Training School: *'Supersymmetry & the Early Universe'*, Oxford, 26–29 Sep 2002
- [IceCube collaboration meeting](#), Oxford, 21–24 Sep 2005
- ASPERA Workshop: *'Theory and Astroparticle Physics'*, Oxford, 17 Mar 2008
- EU Research & Training School: *'Fundamental Physics & Cosmology'*, Oxford, 22–26 Sep 2008
- First LINK Workshop: *'Probing Physics beyond the SM with CTA'*, Abingdon, 12 Nov 2010
- Astroparticle Physics session, [RAS National Astronomy Meeting](#), Llandudno, 17-21 Apr 2011
- [GrahamFest](#), Oxford, 30 Sep 2011
- IoP/IPPP Workshop: *'New paths to particle dark matter'*, Oxford, 29-30 Mar 2012
- NBIA PhD School: *'Neutrinos underground and in the heavens'*, Copenhagen, 23-27 Jun 2014
- 2nd NBIA-APCTP Workshop: *'Cosmology & Astroparticle Physics'*, Copenhagen, 18-22 Aug 2012
- [NBIA-Oxford Colloquium](#), Copenhagen, 13-15 Apr 2015
- NBIA PhD School: *'Neutrinos underground and in the heavens II'*, Copenhagen, 1-5 Aug 2016
- NBIA Workshop: *'Self-interacting dark matter'*, Copenhagen, 1-5 Aug 2017



▷ **Organising Committee:**

- UK Institute for Theoretical High Energy Physics, Cambridge, 1–7 Sep 1991
- UK HEP Forum: ‘*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
  - 28th International Conference on High Energy Physics, Warsaw, 25–31 Jul 1996
- SUSY 98, Oxford, 11–17 Jul 1998
- UK HEP Forum: ‘*New Horizons in Neutrino Physics*’, Abingdon, 8–9 May 1999
- EU Network School: ‘*The Early Universe*’, CERN, 19–22 Apr 2001
- IPPP Workshop: ‘*Phenomenology of Ultra-high-energy Cosmic Rays*’, Durham, 21 June 2002
- First International Conference on ‘*String/M-theory Phenomenology*’, Oxford, 6–11 Jul 2002
- UK HEP Forum: ‘*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: ‘*The Origin of the Universe*’, Mytilene, 24–29 Sep 2007
- IoP/RAS meeting: ‘*The Search for Dark Matter*’, London, 26 Nov 2007
- Astroparticle Physics UK meeting, Oxford, 18–20 Jun 2008
- International Workshop: ‘*Cosmology with the CMB & LSS*’, Pune, 18–31 Aug 2008
- PPAP Community Meeting: ‘*Neutrino & Non-accelerator Physics*’, Birmingham, 15 July 2009
- 9th Hellenic School of Elementary Particle Physics & Gravity, Corfu, 30 Aug–20 Sep 2009
- EU Network School: ‘*Particle Physics & Cosmology*’, Barcelona, 28 Sep–2 Oct 2009
- 10th Hellenic School of Elementary Particle Physics & Gravity, Corfu, 29 Aug–5 Sep 2010
- EU Network School: ‘*Frontiers of Particle Cosmology*’, Lecce, 13–18 Sep 2010
- ICATPP Conference: ‘*Cosmic Rays for Particle and Astroparticle Physics*’, Como, 7–8 Oct 2010
- Cherenkov Telescope Array Collaboration Meeting, Rutherford Lab, 8–11 Nov 2010
- ICTP Workshop: ‘*Looking at the Neutrino Sky*’, Trieste, 20–24 Jun 2011
- CERN Theory Institute: ‘*Dark Matter Underground and in the Heavens*’, Geneva, 18–29 Jul 2011
- 11th Hellenic School of Elementary Particle Physics & Gravity, Corfu, 4–18 Sep 2011
- XII Workshop on High Energy Physics Phenomenology, Mahabaleshwar, 2–8 Jan 2012
- 12th Hellenic School of Elementary Particle Physics & Gravity, Corfu, 8–27 Sep 2012
- Danish National Astronomy Meeting, Sandbjerg Estate, 18–19 Jun 2013
- 13th Hellenic School of Elementary Particle Physics & Gravity, Corfu, 31 Aug–27 Sep 2013
- 1st APCTP-NBIA joint workshop on Cosmology and Astroparticle Physics, Pohang, 21–25 Oct 2013
- 14th Hellenic School of Elementary Particle Physics & Gravity, Corfu, 3–21 Sep 2014
- Dark Matter@LHC, Oxford, 25–27 Sep 2014
- 15th Hellenic School of Elementary Particle Physics & Gravity, Corfu, 1–27 Sep 2015
- 16th Hellenic School of Elementary Particle Physics & Gravity, Corfu, 31 Aug–23 Sep 2016
- Nordic Winter School: ‘*Cosmology and Particle Physics*’, Skeikampen, 2–7 Jan 2017

▷ **Member of International Scientific/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

- ‘*Dark Matter in Astrophysics & Particle Physics*’, Cambridge, 2–6 Aug 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
- *VLVnT11 – Very Large Volume Neutrinos Telescope Workshop*, Erlangen, 12–14 Oct 2011
- *XII Workshop on High Energy Physics Phenomenology*, 2–15 Jan 2012
- *COSGRAV12: Intern. Conf. 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
- *TeVPA 2012*, Mumbai, 11–15 Dec 2012
- *33<sup>rd</sup> ICRC 2013*, Rio de Janeiro, 2–9 Jul 2013
- *TeVPA 2013*, Irvine, 26–29 Aug 2013
- *TeVPA 2014*, Amsterdam, 23–28 Jun 2014
- *Cosmo Cruise 2015*, 2–9 Sep 2015
- *VLVnT – 2015: Very Large Volume Neutrino Telescope*, 14–16 Sep 2015
- *Advances in Astroparticle Physics and Cosmology*, Kolkata, 12–17 Oct 2015
- *TeVPA 2015*, Tokyo, 26–30 Oct 2015
- *PhyStat-nu*, Tokyo, 30 May–1 Jun 2016
- *Workshop on non-standard dark matter*, Warsaw, 2–5 Jun 2016
- *IAU Symposium 324: New Frontiers in Black Hole Astrophysics*, Ljubljana, 12–16 Sep 2016
- *TeVPA 2016*, Geneva, 12–16 Sep 2016
- *Winter School on AstroParticle Physics*, Ootacamund, 21–29 Dec 2016
- *DISCRETE 2016*, Warsaw, 28 Nov–3 Dec 2016
- *International Neutrino Summer School*, Fermilab, 7–18 Aug 2017
- *TeVPA 2017*, Columbus, 7–11 Aug 2017
- *International Neutrino Summer School*, Mainz, 21 May–1 Jun 2018

### Participation in Experiments:

- *BEBC* WA66 Beam Dump Collaboration (Data analysis 1985)
- *Pierre Auger Observatory* (Institutional Representative, 2003–13; Publications Committee)
- *IceCube* (Collaboration Board Member, 2004–; Editor, Yellow Book; Paper Review Committee)
- *Cherenkov telescope Array* (Collaboration Member, 2010–; Requirements Review Committee; Co-editor of Special Issue; Review of Key Science Projects)

### Research Grants:

1. SERC AF Starter Research Grant (‘*Cosmological Probes of Physics Beyond the SM*’) PI, 1993–98 [GR/H90162] – £10,000
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] — €57,140
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] — €132,000
4. British Council ‘*Acciones Integradas*’ Programme (‘*Large-scale Structure*’ network) (Barcelona, Cambridge, Durham, Oxford) Co-I with G Efstathiou (PI) *et al*, 1997–98 — £2,900
5. PPARC Rolling Grant (‘*Theoretical Studies of Elementary Particles*’) Co-I with G Ross (PI) *et al*, 1999–03 [PPA/G/O/2000/00469]; — £360,692

6. PPARC Special Program Grant ('Neutrino Mass')  
Co-I with G Ross (PI), 2000–02 [PPA/G/S/1998/00561] — £87,287
7. EU 5th Framework Programme (Marie Curie training site 'Particle Astrophysics')  
Co-I with J Binney and J Silk (PI), 2000–03 — €158,400
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] — €145,000
9. EU 5th Framework Programme ('Supersymmetry and the Early Universe' TMR network)  
Network Coordinator, 2000–04 [HPRN-CT-2000-00152] — €1.49 M
10. Leverhulme Foundation Major Grant ('Dark Matter')  
Co-I with J Binney and J Silk (PI), 2000–05 [F/08776A] — £433,134
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] — €107,072
12. Joint Research Equipment Initiative ('Beowulf Supercomputer')  
Co-I with J Silk (PI) *et al*, 2000–05 — £127,151
13. EU Marie Curie fellowship ('Non-Baryonic Dark Matter')  
Scientist-in charge (awarded to F Ferrer), 2001–03 [MCFI-2001-00645] — €107,072
14. PPARC Rolling Grant ('Theoretical Studies of Elementary Particles')  
Co-I with G Ross (PI) *et al*, 2003–08 [PPA/G/O/2002/00479] — £562,204
15. PPARC Special Program Grant ('Neutrino Physics')  
Co-I with G Ross (PI), 2004–06 [PPA/G/S/2003/00138] — £72,919
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] — £475,495.68
17. PPARC Senior Fellowship ('Auger & IceCube: Probes of the high energy universe')  
PI, 2006–09 [PPA/C506205/1] — £118,692
18. EU 6th Framework Programme Marie Curie RTN ('The Origin of the Universe')  
Network Coordinator, 2006–10 [MRTN-CT-2006-035863] — €3.53 M
19. John Fell Fund *Strengthening Oxford-India Research Links in Theoretical Physical Sciences*  
PI (with J. Cardy *et al*) 2006–12 — £25,313
20. STFC Research Grant (*UHE cosmic ray research with the Pierre Auger Observatory*)  
PI, 2008–11 [PPA/E007007/1] — £42,428
21. PPARC Rolling Grant ('Theoretical Studies of Elementary Particles')  
Co-I with G Ross (PI) *et al*, 2008–11 [ST/G000492/1] — £1,900,748
22. UKIERI grant (*Interdisciplinary Oxford-India Research Network in Theoretical Physics*)  
Co-I (with J. Cardy *et al*), — £25,313
23. STFC Consolidated Grant ('Theoretical Particle Physics Research')  
PI, 2011–14 [ST/J000507/1] — £989,202
24. IPPP Associateship ('Phenomenology of Dark Matter')  
PI, 2011–12 — £4,000
25. DNRF Niels Bohr Professorship ('Connecting Inner Space & Outer Space')  
PI, 2013–18 [506600-50-36547] — 29 MDKK
26. STFC Consolidated Grant ('Theoretical Particle Physics Research')  
PI, 2014–17 [ST/L000474/1] — £1,107,540
27. EPSRC grant ('Particle acceleration in magnetised shocks')  
Co-I (with G. Gregori (PI) & A. Bell), 2016–19 — £566,044
28. STFC Consolidated Grant ('Theoretical Studies of Elementary Particles')  
PI, 2017–20 [ST/P000770/1] — £711,506

## 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, 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 Network on ‘*Neutrino & the Fundamental Laws of Nature*’, 2007–10
- ▷ Member, UKIERI Network on ‘*Theoretical Physical Sciences*’, 2008–11
- ▷ Member, Oxford node of EU network on ‘*Unification in the LHC era*’, 2009–13 (Paris + Salonicki, Lisbon, Madrid, Bonn, Oxford, Pisa, Trieste, Valencia, Geneva)
- ▷ Associate Member, DFG Research Training Group on ‘*Models of Gravity*’, 2013–

## External Appointments:

- ▷ Maxwell Visiting Fellow, [King’s College, London](#), 2000–05
- ▷ Adjunct Professor, [Tata Institute of Fundamental Research](#), Mumbai, 2006–09
- ▷ Adjunct Professor, [Saha Institute of Nuclear Physics](#), Kolkata, 2008–
- ▷ Scientific Associate, [Discovery Center, Niels Bohr Institute](#), Copenhagen, 2010–20
- ▷ Scientific Associate, [Institute of Particle Physics Phenomenology](#), Durham, 2011–12
- ▷ Niels Bohr Visiting Professor, [Niels Bohr International Academy](#), Copenhagen, 2013–18

## Public Understanding of Science

I worked (1988-89) with [Eklavya](#), a NGO in Bhopal concerned with science teaching and outreach. My main task was to launch a monthly newsletter on science and technology ([Srote](#)) for regional vernacular newspapers. I have engaged in the following science outreach activities in the UK:

- ▷ Oxford Physics: Publicity Committee (1995–96); Participation in Open Days; Science, Engineering & Technology Weeks; Assessment Panel, Undergraduate Speaking Competition (2001–04)
- ▷ Continuing Education, Oxford: Summer School: ‘*Blowing up the universe*’, 15–22 Jul 1995; School: ‘*Cosmic antimatter*’, 23 Jan 1999; Summer School: ‘*Constructing the Universe*’, 24–31 Jul 1999
- ▷ Consultant to BBC science programme makers on several occasions
- ▷ Radio interviews, e.g. BBC Thames Valley, 12 Jan 2000, LBC, London, 27 Apr 2000
- ▷ Assisted the [Royal Institution, London](#) to organise topical exhibition
- ▷ Filmed interview for new [Space Galleries at Royal Greenwich Observatory](#) (Dec 2007)

- ▷ Debate: [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
    - 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 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
    - Oxford Undergraduate Student Conference, St Catherine’s College, 16 Apr 2013
  - ‘*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
- Folkeuniversitetet, NBI, Copenhagen, 8 Dec 2014

▷ 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)
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**Address:**

Rudolf Peierls Centre for Theoretical Physics  
 University of Oxford, 1 Keble Road  
 Oxford OX1 3NP, UK  
 Tel: +44 1865 273962  
 Email: [s.sarkar@physics.ox.ac.uk](mailto:s.sarkar@physics.ox.ac.uk)  
<http://www2.physics.ox.ac.uk/contacts/people/sarkar>

Niels Bohr International Academy  
 Copenhagen University, Blegdamsvej 17  
 2100 Copenhagen, Denmark  
 Tel: +45 353 25225  
 Email: [sarkar@nbi.ku.dk](mailto:sarkar@nbi.ku.dk)  
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- [102] *Measurement of the energy spectrum of cosmic rays above  $10^{18}$  eV using the Pierre Auger Observatory* TOPCITE 100+  
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- [133] [Dark matter profiles and annihilation in dwarf spheroidal galaxies: prospectives for present and future gamma-ray observatories - I. The classical dSphs](#) ♥ TOPCITE 50+  
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- [180] *Search for dark matter annihilations in the Sun with the 79-string IceCube detector*  
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- [183] *Loops and spurs: The angular power spectrum of the galactic synchrotron background* ♥  
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- [205] *Fingerprints of Galactic Loop I on the cosmic microwave background* <sup>♥</sup> \* TOPCITE 50+  
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(with Vincent Bonivard, Celine Combet, Mike Daniel, Stefan Funk, Alex Geringer-Sameth, Jim Hinton, David Maurin, Justin Read, Matt Walker & Mark Wilkinson)
- [219] *Measurement of the atmospheric  $\nu_e$  spectrum with IceCube*  
Physical Review D 91 (2015) 122004 [arXiv:1504.03753]  
(with the IceCube Collaboration)
- [220] *On the interpretation of dark matter self-interactions in Abell 3827* ♥ \* TOPCITE 50+  
Monthly Notices of the Royal Astronomical Society 452 (2015) L54 [arXiv:1504.06576]  
(with Felix Kahlhoefer, Kai Schmidt-Hoberg & Janis Kummer)
- [221] *Search for dark matter annihilation in the Galactic centre with IceCube-79* TOPCITE 50+  
European Physical Journal C75 (2015) 10, 492 [arXiv:1505.07259]  
(with the IceCube Collaboration)
- [222] *Marginal evidence for cosmic acceleration from Type Ia supernovae* ♥ \*  
Nature Scientific Reports 6 (2016) 35596 [arXiv:1506.01354]  
(with Jeppe Trøst Nielsen & Alberto Guffanti)

- [223] *Detection of a Type II<sub>n</sub> Supernova in optical follow-up observations of IceCube neutrino events*  
Astrophysical Journal 811 (2015) 52 [arXiv:1506.03115]  
(with the IceCube Collaboration)
- [224] *Simplified models for dark matter searches at the LHC* TOPCITE 100+  
Physics of the Dark Universe 9-10 (2015) 8–23 [arXiv:1506.03116]  
(with J Abdallah *et al*)
- [225] *Characterization of the atmospheric muon flux in IceCube*  
Astroparticle Physics 78 (2016) 1–27 [arXiv:1506.07981]  
(with the IceCube Collaboration)
- [226] *A combined maximum-likelihood analysis of the high-energy astrophysical neutrino flux measured with IceCube* TOPCITE 100+  
Astrophysical Journal 809 (2015) 98 [arXiv:1507.03991]  
(with the IceCube Collaboration)
- [227] *Evidence for astrophysical muon neutrinos from the northern sky with IceCube* TOPCITE 100+  
Physical Review Letters 115 (2015) 081102 [arXiv:1507.04005]  
(with the IceCube Collaboration)
- [228] *Search for transient astrophysical neutrino emission with IceCube-DeepCore*  
Astrophysical Journal 816 (2016) no.2, 75 [arXiv:1509.05029]  
(with the IceCube Collaboration)
- [229] *Search for features in the spectrum of primordial perturbations using Planck and other datasets* ♥  
Journal of Cosmology & Astroparticle Physics 12 (2015) 052 [arXiv:1510.03338]  
(with P. Hunt)
- [230] *Search for astrophysical tau neutrinos in three years of IceCube data*  
Physical Review D 93 (2016) 022001 [arXiv:1509.06212]  
(with the IceCube Collaboration)
- [231] *Searches for relativistic magnetic monopoles in IceCube*  
European Physical Journal C76 (2016) 133 [arXiv:1511.01350]  
(with the IceCube Collaboration)
- [232] *First combined search for neutrino point-sources in the Southern Hemisphere with the ANTARES and IceCube neutrino telescopes*  
Astrophysical Journal 823 (2016) 65 [arXiv:1511.02149]  
(with the ANTARES & IceCube Collaborations)
- [233] *The prompt atmospheric neutrino flux in the light of LHCb* ♥  
Journal of High Energy Physics 02 (2016) 130 [arXiv:1511.06346]  
(with Rhorry Gauld, Juan Rojo, Luca Rottoli and Jim Talbert)
- [234] *Footprints of Galactic Loop I on cosmic microwave background maps* ♥  
Journal of Cosmology & Astroparticle Physics 03 (2016) 023 [arXiv:1511.08207]  
(with Sebastian von Hausegger, Hao Liu and Philipp Mertsch)
- [235] *Search for correlations between the arrival directions of IceCube neutrino events and ultrahigh-energy cosmic rays detected by the Pierre Auger Observatory and the Telescope Array*  
Journal of Cosmology & Astroparticle Physics 01 (2016) 037 [arXiv:1511.09408]  
(with the IceCube, Pierre Auger & Telescope Array Collaborations)
- [236] *Improved limits on dark matter annihilation in the Sun with the 79-string IceCube detector & implications for supersymmetry*  
Journal of Cosmology & Astroparticle Physics 04 (2016) 022 [arXiv:1601.00653] TOPCITE 100+  
(with the IceCube Collaboration)

- [237] *An all-sky search for three flavors of neutrinos from gamma-ray bursts with the IceCube Neutrino Observatory*  
Astrophysical Journal 824 (2016) 115 [arXiv:1601.06484]  
(with the IceCube Collaboration)
- [238] *High-energy neutrino follow-up search of gravitational wave event GW150914 with ANTARES and IceCube*  
Physical Review D93 (2016) 122010 [arXiv:1602.05411] TOPCITE 50+  
(with the ANTARES, IceCube & LIGO Collaborations)
- [239] *Anisotropy in cosmic-ray arrival directions in the Southern Hemisphere with six years of data from the IceCube detector*  
Astrophysical Journal 826 (2016) 220 [arXiv:1603.01227]  
(with the IceCube Collaboration)
- [240] *Lowering IceCube's energy threshold for point source searches in the southern sky*  
Astrophysical Journal 824 (2016) L28 [arXiv:1605.00163]  
(with the IceCube Collaboration)
- [241] *Searches for sterile neutrinos with the IceCube detector*  
Physical Review Letters 117 (2016) 071801 [arXiv:1605.01990]  
(with the IceCube Collaboration)
- [242] *Neutrino oscillation studies with IceCube-DeepCore*  
Nuclear Physics B908 (2016) 161-177  
(with the IceCube Collaboration)
- [243] *All-flavour search for neutrinos from dark matter annihilations in the Milky Way with IceCube/DeepCore*  
European Physics Journal C76 (2016) 1-14 [arXiv:1606.00209]  
(with the IceCube Collaboration)
- [244] *Search for sources of high energy neutrons with four years of data from the IceTop detector*  
Astrophysical Journal 830 (2016) 129 [arXiv:1607.05614]  
(with the IceCube Collaboration)
- [245] *Constraints on ultra-high-energy cosmic ray sources from a search for neutrinos above 10 PeV with IceCube*  
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(with the IceCube Collaboration)
- [246] *Frames of most uniform Hubble flow* ♥  
Journal of Cosmology and Astroparticle Physics 10 (2016) 016 [arXiv:1607.07377]  
(with David Kraljic)
- [247] *Observation and characterisation of a cosmic muon neutrino flux from the northern hemisphere using six years of IceCube data* TOPCITE 50+  
Astrophysical Journal 833 (2016) 1 [arXiv:1607.08006]  
(with the IceCube Collaboration)
- [248] *First search for dark matter annihilations in the Earth with the IceCube Detector*  
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(with the IceCube Collaboration)
- [249] *All-sky search for time-integrated neutrino emission from astrophysical sources with 7 years of IceCube data*  
Astrophysical Journal 835 (2017) 151 [arXiv:1609.04981]  
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- [250] *Very high-energy gamma-ray follow-up program using neutrino triggers from IceCube*  
Journal of Instrumentation 11 (2016) P11009 [arXiv:1610.01814]  
(with the IceCube & MAGIC & VERITAS Collaborations)
- [251] *The contribution of Fermi-2LAC blazars to the diffuse TeV-PeV neutrino flux*  
Astrophysical Journal 835 (2017) 45 [arXiv:1610.03874]  
(with the IceCube Collaboration)
- [252] *The IceCube Neutrino Observatory: Instrumentation and Online Systems*  
Journal of Instrumentation 12 (2017) P03012 [arXiv:1612.05093]  
(with the IceCube Collaboration)
- [253] *Search for annihilating dark matter in the Sun with 3 years of IceCube data*  
European Journal of Physics C 77 (2017) 146 [arXiv:1612.05949]  
(with the IceCube Collaboration)
- [254] *The IceCube realtime alert system*  
Astroparticle Physics 92 (2017) 30 [arXiv:1612.06028]  
(with the IceCube Collaboration)
- [255] *Search for sterile neutrino mixing using three years of IceCube DeepCore data*  
Physical Review D95 (2017) 112002 [arXiv:1702.05160]  
(with the IceCube Collaboration)
- [256] *Multiwavelength follow-up of a rare IceCube neutrino multiplet*  
Astronomy & Astrophysics, in press [arXiv:1702.06131]  
(with the IceCube Collaboration)
- [257] *Extending the search for muon neutrinos coincident with gamma-ray bursts in IceCube data*  
Astrophysical Journal 843 (2017) 112 [arXiv:1702.06868]  
(with the IceCube Collaboration)
- [258] *Search for high-energy neutrinos from gravitational wave event GW151226 and candidate LVT151012 with ANTARES and IceCube*  
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(with the ANTARES, IceCube, LIGO & VIRGO Collaborations)
- [259] *High redshift radio galaxies and divergence from the CMB dipole* <sup>♥</sup>  
Monthly Notices of the Royal Astronomical Society 471 (2017) 1045 [arXiv:1703.09376]  
(with J. Colin, R. Mohayaee and R. Rameez)
- [260] *Prospects for CTA observations of the young SNR RX J1713.7-3946*  
Astrophysical Journal 840 (2017) 74 [arXiv:1704.04136]  
(with the CTA Consortium)
- [261] *Search for astrophysical sources of neutrinos using cascade events in IceCube*  
Astrophysical Journal 846 (2017) 136 [arXiv:1705.02383]  
(with the IceCube Collaboration)
- [262] *Measurement of the  $\nu_\mu$  energy spectrum with IceCube-79*  
European Physics Journal C, accepted [arXiv:1705.07780]  
(with the IceCube Collaboration)
- [263] *Search for neutrinos from dark matter annihilations in the centre of the Milky Way with 3 years of IceCube/DeepCore*  
European Physics Journal C 77 (2017) 627 [arXiv:1705.08103]  
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- [264] *Constraints on Galactic neutrino emission with seven years of IceCube data*  
Astrophysical Journal 849 (2017) 67 [arXiv:1707.03416]  
(with the IceCube Collaboration)
- [265] *Multi-messenger observations of a binary neutron star merger*  
Astrophysical Journal Letters 848 (2017) L12 [arXiv:1710.05833]  
(with the LIGO, VIRGO, Fermi GBM, INTEGRAL, IceCube ... Collaborations)
- [266] *Measurement of the multi-TeV neutrino cross section with IceCube using Earth absorption*  
Nature, in press  
(with the IceCube Collaboration)
- Under review:
- [267] *Measurement of atmospheric neutrino oscillations at 6-56 GeV with IceCube DeepCore*  
Physical Review D, submitted [arXiv:1707.07081]  
(with the IceCube Collaboration)
- [268] *Axion driven cosmic magneto-genesis prior to the QCD crossover* ♡  
Physical Review Letters, submitted [arXiv:1708.07614]  
(with F. Miniati, G. Gregori & B. Reville)
- [269] *Neutrino interferometry for high-precision tests of Lorentz symmetry with IceCube*  
Nature, submitted [arXiv:1709.03434]  
(with the IceCube Collaboration)
- [270] *Search for nonstandard neutrino interactions with IceCube DeepCore*  
Physical Review D, submitted [arXiv:1709.07079]  
(with the IceCube Collaboration)
- [271] *Search for high-energy neutrinos from binary neutron star merger GW170817 with ANTARES, IceCube, and the Pierre Auger Observatory*  
Astrophysical Journal, submitted [arXiv:1710.05839]  
(with the IceCube Collaboration)

Selected invited talks, lectures and reviews:

- [272] *Particle physics & the standard cosmology* ♡  
in 'Superstrings, Supergravity & Unified Theories', eds. G. Furlan *et al* (World-Scientific, 1986), pp. 465–493
- [273] *Cosmological and astrophysical constraints on particle physics* ♡  
Proc. XXVI International Symp. on Multiparticle Dynamics, Seewinkel, eds. M. Markytan *et al*, (World Scientific, 1986), pp. 863–873
- [274] *Non-baryonic dark matter* ♡  
in 'Observational Tests of Cosmological Inflation', NATO ASI C348, Durham eds. T. Shanks *et al* (Kluwer Academic, 1991), pp. 91–102
- [275] *Primordial nucleosynthesis & dark matter* ♡  
in 'Dark Matter in Astro- & Particle Physics', Heidelberg, eds. H.V. Klapdor & Y. Ramachers (World Scientific, 1997) pp. 235–249 [astro-ph/9611232]
- [276] *Supersymmetric inflation & large-scale structure* ♡  
in 'Current Topics in Physics', Seoul, eds. Y.M. Cho *et al* (World Scientific, 1998) Vol. 2, pp. 961-971 [hep-ph/9610248]

- [277] *Cosmological implications of neutrinos* ♥  
in 'Weak Interactions & Neutrinos 1997', Capri, eds. F. Fiorillo *et al*, Nuclear Physics B (Proc. Suppl.) 66A (1998) 168–180 [hep-ph/9710273]
- [278] *Big bang nucleosynthesis: Reprise* ♥  
in 'Dark Matter in Astrophysics & Particle Physics', Heidelberg eds. H.V. Klapdor & L. Baudis (Adam Hilger, 1999) pp. 108–130 [astro-ph/9903183]
- [279] *The standard big bang cosmology* ♥  
in 'Large Scale Structure Formation', Kish, eds. R. Mansouri & R. Brandenberger (Kluwer Academic, 2000) pp. 37–96
- [280] *Cosmic ray signatures of massive relic particles* ♥  
in COSMO-99: Proc. 3rd Intern. Workshop on Particle Physics & the Early Universe, Trieste, eds. U. Cotti *et al* (World Scientific, 2000) pp. 77–90 [hep-ph/0005256]
- [281] *Introduction to big bang cosmology* ♥  
'Recent Developments in Particle Physics & Cosmology', Cascais, eds. G. Branco, Q. Shafi & J. Silva-Marcos (Kluwer Academic, 2001) pp.219–280
- [282] *Evidence for an inflationary phase transition from the LSS and CMB data* ♥  
Nuclear Physics B (Proc. Suppl.) 95 (2001) pp. 66–69 [astro-ph/0012284]  
(with J. Barriga, E. Gaztañaga & M. Santos)
- [283] *Big-bang nucleosynthesis* (in 'The Review of Particle Physics', Particle Data Group) ♥  
Physical Review D66 (2002) 010001-162 TOPCITE 5000+  
(with B. Fields)
- [284] *New results in cosmology* ♥  
Proc. International Conf. on High Energy Physics, Budapest, 12-18 July 2001, JHEP PRHEP-hep2001/299 [hep-ph/0201140]
- [285] *Ultra high energy cosmic rays & new physics* ♥  
in COSMO-01: Proc. Fifth International Workshop on Particle Physics & the Early Universe, Rovaniemi, 31 Aug–4 Sep 2001 [hep-ph/0202013]
- [286] *New physics from ultrahigh energy cosmic rays* ♥  
Acta Physica Polonica B35 (2004) 351–364 [hep-ph/0312223]
- [287] *Measuring the baryon content of the universe: BBN vs CMB* ♥  
in 'Frontiers of the Universe', eds. C. Celnekier & J. Tran Thanh Van (The Gioi Publishers, 2004) pp. 53-64 [astro-ph/0205116]
- [288] *Neutrinos from the Big Bang* ♥  
Proc. Indian National Science Academy, 70A (2004) 163–178 [hep-ph/0302175]
- [289] *Big-bang nucleosynthesis* (in the 'Review of Particle Physics' by the Particle Data Group) ♥  
Physics Letters B592 (2004) 1 [astro-ph/0406663] TOPCITE 5000+  
(with B. Fields)
- [290] *Measuring the cosmological density perturbation* ♥  
Proc. 'The Density Perturbation in the Universe', Athens, 25-26 June 2004, eds. M. Axenides *et al*, Nuclear Physics B (Proc. Suppl.) 148 (2005) 1–6 [hep-ph/0503271]
- [291] *Einstein's universe: the challenge of dark energy* ♥  
in 'The legacy of Albert Einstein', ed. S.R. Wadia (World Scientific 2007) pp.207–224
- [292] *Big-bang nucleosynthesis* (in the 'Review of Particle Physics', Particle Data Group) ♥  
Journal of Physics G 33 (2006) 1 [astro-ph/0601514] TOPCITE 5000+  
(with B. Fields)

- [293] *Implications of cosmic ray results for UHE neutrinos* <sup>♥</sup>  
Proc. Neutrino 2008, Christchurch, 25-31 May 2008, eds. J. Adams *et al*, [arXiv:0811.0375]
- [294] *Big-bang nucleosynthesis* (in the ‘Review of Particle Physics’ by the Particle Data Group) <sup>♥</sup>  
Physics Letters B667 (2008) 1 TOPCITE 5000+  
(with B. Fields)
- [295] *Does cosmological structure formation require dark energy?* <sup>♥</sup>  
in ‘Dark Energy and Dark Matter’, Lyon, 7–11 July 2008, eds. E. Pécontal *et al*, EAS Pub. Ser. 36 (2009) 3–9
- [296] *Big-bang nucleosynthesis* (in the ‘Review of Particle Physics’ by the Particle Data Group) <sup>♥</sup>  
Journal of Physics G 37 (2010) 075021 TOPCITE 5000+  
(with B. Fields)
- [297] *Big-bang nucleosynthesis* (in the ‘Review of Particle Physics’ by the Particle Data Group) <sup>♥</sup>  
Physical Review D86 (2012) 010001 TOPCITE 5000+  
(with B. Fields)
- [298] *Theory summary: Very high energy cosmic rays* <sup>♥</sup>  
European Physical Journal Web Conf. 52 (2013) 12001
- [299] *Big-bang nucleosynthesis* (in the ‘Review of Particle Physics’ by the Particle Data Group) <sup>♥</sup>  
Chinese Physics C38 (2014) 090001 [arXiv:1412.1408] TOPCITE 5000+  
(with B. Fields & P. Molaro)
- [300] *Big-bang nucleosynthesis* (in the ‘Review of Particle Physics’ by the Particle Data Group) <sup>♥</sup>  
Chinese Physics C40 (2016) 100001 TOPCITE 1000+  
(with B. Fields & P. Molaro)

#### Reports:

- [301] *Summary of the NOW’98 Phenomenology Working Group: The BBN limit on  $N_\nu$*  <sup>♥</sup>  
[hep-ph/9906251]  
(with S.M. Bilenky *et al*)
- [302] *Working group report: Astroparticle and neutrino physics* <sup>♥</sup>  
Pramana 67 (2006) 735–742  
(with R. Gandhi, S. Mohanty, T. Souradeep *et al.*)
- [303] *Design concepts for the Cherenkov Telescope Array* TOPCITE 500+  
Experimental Astronomy 32 (2011) 193–316 [arXiv:1008.3703]  
(with the CTA collaboration)
- [304] *Fundamental physics at the intensity frontier* TOPCITE 250+  
[arXiv:1205.2671]  
(with J.L. Hewett *et al*)
- [305] *Introducing the CTA concept* TOPCITE 250+  
Astroparticle Physics 43 (2013) 3–18  
(with the CTA collaboration)
- [306] *PINGU sensitivity to the neutrino mass hierarchy*  
Proc. Snowmass 2013 [arXiv:1306.5846]  
(with the IceCube Collaboration)
- [307] *Letter of Intent: The Precision IceCube Next Generation Upgrade (PINGU)* <sup>♥</sup> TOPCITE 100+  
[arXiv:1401.2046]  
(with the IceCube-PINGU Collaboration)

- [308] *IceCube-Gen2: A Vision for the Future of Neutrino Astronomy in Antarctica* TOPCITE 100+  
[arXiv:1412.5106]  
(with the IceCube-Gen2 Collaboration)
- [309] *Dark matter benchmark models for early LHC Run-2 searches* TOPCITE 100+  
[arXiv:1507.00966]  
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- [310] *PINGU: A vision for neutrino and particle physics at the South Pole*  
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(with the IceCube-Gen2 collaboration)
- [311] *Science with the Cherenkov Telescope Array* ♥  
International Journal of Modern Physics D, to appear [arXiv:1709.07997]  
(with the CTA Consortium)

Special Issues:

- [312] *Special issue on “Seeing the high-energy universe with the Cherenkov Telescope Array”* ♥  
Astroparticle Physics 43 (2013) 1–365  
(Edited with J. Hinton, J. Knapp and D. Torres)
- [313] *Neutrinos and cosmic rays observed by IceCube, in Special issue on “Origins of Cosmic Rays”*  
Advances in Space Research, to appear [arXiv:1701.03731]  
(with the IceCube Collaboration)

Conference papers: Over 2000 to date, e.g.

- [314] *Energy spectra & charge states of low energy cosmic rays in the SKYLAB experiment* ♥  
Space Research XX (1980) 259–262  
(with S. Biswas, N. Durgaprasad & V.S. Venkatavaradan)
- [315] *Gamma ray emission from supernova remnants* ♥  
in ‘Non-Solar Gamma Rays’, ed. M. Rycroft (Pergamon Press, 1980), p.57–60  
(with R. Cowsik)
- [316] *The evolution of supernova remnants as radio sources* ♥  
Proc. IAU Symp. 101: ‘Supernova remnants & their X-ray emission’, Venice, ed. J. Danziger & P. Gorenstein, (Reidel, 1983), p.187–192  
(with R. Cowsik)
- [317] *Neutrino detectors as probes of massive cosmological relics* ♥  
Proc. 2nd Intern. Workshop on ‘Theoretical & Phenomenological Aspects of Underground Physics’, eds. A. Morales *et al*, Nuclear Physics B (Proc. Suppl.) 28A (1992) 405–408
- [318] *Successful supersymmetric inflation* ♥  
Proc. International EPS Conf. on High Energy Physics, Brussels, ed. J. Lemonne *et al* (World Scientific, 1996), p.95–98 [hep-ph/9510369]
- [319] *The cosmic ray energy spectrum & related measurements with the Pierre Auger Observatory*  
Submissions to the 31<sup>st</sup> ICRC, Lodz (2009) [arXiv:0906.2189] TOPCITE 50+  
(with the Pierre Auger collaboration)
- [320] *Studies of cosmic ray composition & air shower structure with the Pierre Auger Observatory*  
Submissions to the 31<sup>st</sup> ICRC, Lodz (2009) [arXiv:0906.2319] TOPCITE 50+  
(with the Pierre Auger collaboration)



- [321] *Astrophysical sources of cosmic rays & related measurements with the Pierre Auger Observatory*  
Submissions to the 31<sup>st</sup> ICRC, Lodz (2009) [arXiv:0906.2347] TOPCITE 50+  
(with the Pierre Auger collaboration)
- [322] *Light asymmetric dark matter* ♥  
Proc. 6<sup>th</sup> Patras Workshop on Axions, WIMPs & WISPs, Zurich, 5–9 Jul 2010, eds. J. Jaeckel *et al*  
(with M. T. Frandsen)
- [323] *The Pierre Auger Observatory I: The cosmic ray energy spectrum & related measurements*  
Contribution to the 32<sup>nd</sup> ICRC, Beijing (2011) [arXiv:1107.4809] TOPCITE 100+  
(with the Pierre Auger collaboration)
- [324] *The Pierre Auger Observatory II: Studies of cosmic ray composition & hadronic interactions*  
Contribution to the 32<sup>nd</sup> ICRC, Beijing (2011) [arXiv:1107.4804] TOPCITE 100+  
(with the Pierre Auger collaboration)
- [325] *The Pierre Auger Observatory III: Other astrophysical observations* TOPCITE 50+  
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- [326] *The Pierre Auger Observatory V: Enhancements* TOPCITE 50+  
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- [327] *The ‘PAMELA anomaly’ indicates a nearby cosmic ray accelerator* ♥  
Proc. 12<sup>th</sup> ICATPP, Como, eds. S. Giani *et al* (World Scientific, 2011) 535–543 [arXiv:1108.1753]  
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- [328] *2nd-order Fermi acceleration as the origin of the Fermi bubbles* ♥  
Nuclear Instruments and Methods in Physics Research A, 692 (2012) 265–268 [arXiv:1108.1754]  
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- [329] *Quantifying uncertainties in the high energy neutrino cross-section* ♥  
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- [330] *A hadronic explanation of the lepton anomaly* ♥  
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(with P. Mertsch)
- [331] *Full-Sky Analysis of cosmic-ray anisotropy with IceCube and HAWC*  
Submissions to the 34<sup>th</sup> ICRC, The Hague (2015) [arXiv:1510.04134]  
(with the HAWC & IceCube collaborations)
- [332] *CTA contributions to the 34th International Cosmic Ray Conference*  
Submissions to the 34<sup>th</sup> ICRC, The Hague (2015) [arXiv:1508.05894]  
(with the CTA collaboration)
- [333] *The IceCube Neutrino Observatory Part I: Point source searches*  
Submissions to the 34<sup>th</sup> ICRC, The Hague (2015) [arXiv:1510.05222]  
(with the IceCube collaboration)
- [334] *The IceCube Neutrino Observatory Part II: Atmospheric and astrophysical diffuse neutrino searches of all flavors*  
Submissions to the 34<sup>th</sup> ICRC, The Hague (2015) [arXiv:1510.05223] TOPCITE 100+  
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- [335] *The IceCube Neutrino Observatory Part III: Cosmic rays*  
Submissions to the 34<sup>th</sup> ICRC, The Hague (2015) [arXiv:1510.05225]  
(with the IceCube collaboration)
- [336] *The IceCube Neutrino Observatory Part IV: Searches for dark matter and exotic Particles*  
Submissions to the 34<sup>th</sup> ICRC, The Hague (2015) [arXiv:1510.05226]  
(with the IceCube collaboration)
- [337] *The IceCube Neutrino Observatory Part V: Neutrino oscillations and supernova searches*  
Submissions to the 34<sup>th</sup> ICRC, The Hague (2015) [arXiv:1510.05227]  
(with the IceCube collaboration)
- [338] *IceCube-Gen2 - The next generation neutrino observatory at the South Pole*  
Submissions to the 34<sup>th</sup> ICRC, The Hague (2015) [arXiv:1510.05228]  
(with the IceCube-Gen2 collaboration)
- [339] *CTA contributions to the 35th International Cosmic Ray Conference*  
Submissions to the 35<sup>th</sup> ICRC, Busan (2017) [arXiv:1709.03483]  
(with the CTA collaboration)
- [340] *The IceCube Neutrino Observatory Part I: Searches for the sources of astrophysical neutrinos*  
Submissions to the 35<sup>th</sup> ICRC, Busan (2017) [arXiv:1710.01179]  
(with the IceCube collaboration)
- [341] *The IceCube Neutrino Observatory Part II: Properties of the atmospheric and astrophysical neutrino flux*  
Submissions to the 35<sup>th</sup> ICRC, Busan (2017) [arXiv:1710.01191]  
(with the IceCube collaboration)
- [342] *The IceCube Neutrino Observatory Part III: Cosmic rays*  
Submissions to the 35<sup>th</sup> ICRC, Busan (2017) [arXiv:1710.01194]  
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- [343] *The IceCube Neutrino Observatory Part IV: Searches for beyond the Standard Model physics*  
Submissions to the 35<sup>th</sup> ICRC, Busan (2017) [arXiv:1710.01197]  
(with the IceCube collaboration)
- [344] *The IceCube Neutrino Observatory Part V: Solar flares, Supernovae, Event reconstruction, Education & Outreach*  
Submissions to the 35<sup>th</sup> ICRC, Busan (2017) [arXiv:1710.01201]  
(with the IceCube collaboration)
- [345] *The IceCube Neutrino Observatory Part VI: IceCube-Gen2, the Next Generation Neutrino Observatory*  
Submissions to the 35<sup>th</sup> ICRC, Busan (2017) [arXiv:1710.01207]  
(with the IceCube collaboration)

♡ Papers to which I have made a significant contribution      \* 20 best publications      1 Nov 2017

<sup>1</sup>ADS: 289 refereed papers/45,696 cites,  $h$ -index=75; ResearcherID: 302 refereed papers/45,576 cites,  $h$ -index=71  
ArXiv: 319 articles;      GOOGLE SCHOLAR: 84,781 cites,  $h$ -index=96 (45,426 cites since 2012,  $h$ -index=77)  
<sup>2</sup>INSPIRE: 276 papers/69,097 cites,  $h_{\text{HEP}}$ =89 (excluding *Review of Particle Physics*: 268 papers/25,004 cites)  
[Of my refereed papers (excluding *Review of Particle Physics*), 8 are ‘renowned’ (500+ cites), 12 ‘famous’  
(250–500 cites), 50 ‘very well-known’ (100–250 cites), 73 ‘well-known’ (50–99 cites) & 100 ‘known’ (10–49 cites)]