Pankaj Jain

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Birth Date: 1 April, 1960

Education:

Year	degree	Subject	Institution
1988	Ph.D.	Theoretical Particle Physics	Syracuse University
1982	M.S.	Physics	I.I.T., New Delhi, India

Employment:

Institution	Position	From	To
M.I.T., Cambridge	Research Associate	Sept. 1988	Aug. 1989
W. Virginia Univ., Morgantown, WV	Visiting Assistant Professor	Sept. 1989	Aug. 1990
Univ. of Kansas, Lawrence, KS	Research Associate	Sept. 1990	Aug. 1993
Univ. of Oklahoma, Norman, OK	Visiting Assistant Professor	Sept. 1993	Dec. 1994
I.I.T., Kanpur, India	Assistant Professor	Jan. 1995	Nov. 1999
I.I.T., Kanpur, India	Associate Professor	Dec. 1999	Dec. 2003
I.I.T., Kanpur, India	Professor	Dec. 2003	present

Research Interests:

Elementary Particle Physics, Particle Astrophysics and Cosmology, Large Scale Anisotropy in the Universe, Cosmic Microwave Background Radiation, Cosmic Birefringence, Ultra High Energy Cosmic Rays, Active Galactic Nuclei, X-ray Binaries, Gravitational Waves, Low Energy Nuclear Fusion, Cosmological and Astrophysical Signatures of axions and other very light mass particles, Neutrino Astrophysics, Strong Interactions, Quantum Chromodynamics, Exclusive Hadronic Processes, Color Transparency, Low Scale Gravity, Relativistic Bound State Equations, Effective Lagrangians for Strong Interactions, Skyrme Model, 1+1 Dimensional Soliton Models, Standard Model, Physics beyond the Standard Model, Technicolor Theories, 3-3-1 Model

Important Research Contributions:

- I have theoretically shown that nuclear fusion reactions can take place at low energies, as seen in many experiments. The reaction gets dominant contribution at second order in perturbation theory. The Coulomb barrier is evaded by the contribution of high energy intermediate states. Despite the evasion of Coulomb barrier, the rate is very small in free space and special conditions are required to get an observable rate. These conditions are met only in condensed medium.

- I developed a general theoretical framework to describe the radio wave signal of cosmic rays generated after refection from ice surface. The formalism involves no uncontrolled approximations and can be reliably applied to ANITA data in order to deduce the properties of incident cosmic rays.

- I showed that there exists considerable evidence for a preferred direction in the universe pointing roughly in the direction of the Virgo cluster. I argued that five independent observations, namely (1) Radio polarizations from distance AGNS, (2) Optical polarizations from Quasars, (3) CMBR

dipole, (4) CMBR quadrupole and (5) CMBR octopole indicate a preferred direction pointing towards Virgo. The chance alignment of these five axes is found to be highly improbable.

Later it was also found that the dipole anisotropy in the source counts and sky brightness of radio sources is significantly larger than the expectation based on our motion relative to the cosmic frame of rest. A similar excess was also seen in the dipole in the case of significantly polarized sources as well as in the polarized flux. This provides further evidence in favor of anisotropy in the Universe.

- I discovered that the observed radio wave polarizations from distant radio galaxies are not distributed isotropically on the sky. The polarization angles were found to show a dipole anisotropy after taking out the contribution due to Faraday Rotation.

- I analyzed the optical polarization data from distant quasars. For this purpose I developed a new statistical procedure which was designed to test the alignment of polarizations from sources widely separated from one another. By applying this method to the observed data I found that the optical polarizations are correlated over very large distances of the order of 1 Gpc.

  I found a similar effect in radio polarizations over a distance scale of 100 Mpc. This has been independently confirmed by other authors using the same as well as different radio data sets.

- I have formulated the dipole modulation model in CMBR polarizations. I have also shown that the signal of dipole modulation in TE and ET modes would be different. Here T and E represent CMB temperature and E mode polarization.

- I argued that the observed signals of large scale anisotropy may arise due to perturbation modes generated during the early pre-inflationary phase of cosmic evolution. Within the framework of the Big Bang model, the Universe need not be isotropic or homogeneous at this time. It acquires this property during the early phase of inflation. Hence the perturbation modes generated during this time need not obey the cosmological principle. For a wide range of parameters, these modes can re-enter the horizon before the current time and hence can affect observations.

- I showed that supersymmetry protects Quantum Field Theory from acquiring large Lorentz violating contributions from quantum gravity effects. I also predicted that quantum gravity leads to Lorentz violating effects of order M^2_{Susy}/M^2_{Planck}, where M_{Susy} is the scale of supersymmetry breaking.

- I introduced a new method to extract CMB signal from the raw data. The method does not rely on any external input, such as the foreground or detector noise modelling. It is based on the assumption that the CMB signal is independent of frequency. The method has been applied successfully to the WMAP data to extract the CMB temperature.

- In 2005 I showed that the Supernova Type 1a data used to deduce the existence of dark energy is biased. I found that the host extinctions show considerable correlation with the residuals. There is no obvious reason why such a correlation should exist and hence the procedure used to extract host extinctions at that time appears to be flawed.

- I have shown that the proton's Pauli form factor F_2 gets dominant contribution from the orbital angular momentum of quarks inside the proton.

- I developed a new data analysis procedure which led to the experimental discovery of color transparency, namely transparency of nuclear medium to propagation of hadrons under certain conditions. The experiment to look for this effect was performed in 1988 at Brookhaven National

laboratory. However due to theoretical bias the effect remained hidden until 1993, when it was discovered by myself with the application of the new data analysis procedure which made minimal theoretical assumptions.

- I performed a feasibility study for using diffuse high energy cosmic ray neutrinos for performing earth's tomography using Km^3 scale neutrino detectors. These detectors are now operational for the main purpose of opening a new window on the cosmos. I have shown, by developing a new data analysis procedure which makes optimal use of the limited number of events likely to be observed in these detectors, that they will also provide useful information about the earth's density profile near the core. The data analysis procedure iteratively improves the earth's density

Courses taught at IITK:

Introductory Mechanics

Introductory Electrodynamics

Introduction to Particle Physics

Introduction to Nuclear Physics

High Energy Physics

Review of Classical Physics

Review of Electrodynamics

Advanced topics in Particle Physics

Introduction to Atmospheric Physics

Quantum Field Theory

Nonperturbative Aspects of Quantum Field Theory

Group Theory

Physics of Universe

General Relativity and Cosmology

Cosmology

Astrophsics

Electrodynamics

Nuclear and Particle Physics

High Energy Astrophysics of Binary Star Systems

Radio Astronomy

Mathematical Methods in Space Science & Astronomy

Ph.D Students:

Prasanta Das: currently faculty member at BITS, Goa

S. Sarala: currently employed by Infosys, Bangalore

Sukanta Panda: currently faculty member at IISER, Bhopal

Rajib Saha: currently faculty member at IISER, Bhopal

Subhayan Mandal: currently faculty member at MNIT, Jaipur

Subhadip Mitra: currently faculty member at IIIT, Hyderabad

Pramoda Samal: currently faculty member at Utkal University, Bhubaneshwar

Pavan K. Aluri: currently faculty member at BHU IIT, Varanasi

Pranati Rath: currently faculty member at Khallikote autonomous college, Berhampur

Gopal: currently faculty member at VIT Vellore

Alekha Chandra Nayak: currently faculty member at NIT Meghalaya

Naveen K. Singh: currently faculty member at Sir PT Sarvajanik College of Science, Surat, Gujarat

Sumeet Dagaonkar: currently employed with Quazar Technologies

Prabhakar Tiwari: currently faculty member at GTIIT, China

Rahul Kothari: currently faculty member at IIT Mandi

Shamik Ghosh: currently post doc at LBL, Berkeley, USA

Ravindra K. Verma: currently postdoctoral fellow at Florida Institute of Technology

Khun Sang Phukon: currently postdoctoral fellow at Birmingham University

Paramita Dasgupta: currently postdoctoral fellow at University Libre de Bruxelles

Prasenjit Sanyal: currently postdoctoral fellow at Asia Pacific Center for Theoretical Physics

Divya Rawat: currently post doctoral fellow at IUCAA

Fahim Varsi: working on cosmic rays

Ruchika Dhaka: Working on x-ray binaries

Harishyme Kumar: Working in the area of nuclear physics

Ashish Kumar: Working in the area of Radio Astronomy

Mohit Panwar: Working in the area of Radio Astronomy

Gurmeet Singh: Working in the area of Radio Astronomy

Kewal Anand: Working in X-ray binaries

Vaibhav Sharma: Working in X-ray binaries

Sanjay Khatik: Working in the area of Radio Astronomy

Akash Gandhi: Working in Cosmology

Books

Electronic Book, "Introduction to Astronomy and Astrophysics", prepared under the MHRD project Benchmarking of Information and Communication Technology (ICT) Modules in Physics and Chemistry.

Introduction to Astronomy and Astrophysics, published by CRC press (Taylor & Francis).

Administration and other Responsibilities:

Physics Department Representative for the Counselling Service (1995-1997)

Physics Department coordinator for placement and summer training (1997-1999)

Physics Department Colloquium and TPSC coordinator (1998-2002 and currently)

Physics Department DPGC member (1997-1999)

Physics Department Budget committee member (1998-2002)

National Advisory Committee, DAE symposium on Nuclear Physics

National Organization Committee, DAE symposium on Particle Physics

DPGC convenor, (2003-2005)

Convenor, High Energy Group

Physics Department Colloquium Coordinator

Physics Department Computer Coordinator

Associate Dean, Academics

Referee: Physical Review D, Physical Review C, Physical Review Letters, Monthly Notices of the Royal Astronomical Society, Journal of Cosmology and Astroparticle Physics, Modern Physics Letters A, International Journal of Modern Physics D, European Physics Letters B, European Physical Journal C, Pramana, Annals of Physics, Classical and Quantum Gravity, Defence Science Journal, Applied Optics, Asian Journal of Geoinformatics, Proceedings of the National Academy of Sciences.

Conferences Organized:

International Workshop QCD 2002, held at IIT Kanpur during 18-22 November, 2002. Proceedings of the workshop published by Pramana.

Indian Conference on Cosmology and Galaxy Formation, ICCGF, 2009, held at IIT Kanpur from October 30 to November 1, 2009

Community Service:

Member of the minimum wage monitoring committee (MWMC).

Secretary, Faculty Club, IIT Kanpur.

Faculty Advisor, Astronomy Club, IIT Kanpur

Virtual Laboratory:

Development of virtual astronomy/astrophysics laboratory for undergraduate students. The virtual laboratory is available at the web link http://202.3.77.17/AstroWebPages/.

Awards and Grants:

- Guru Nanak Dev University medal for standing IIIrd in pre-university examination (1977).
- *Production of short animated audio visual instructional aids for undergraduate physics courses which illustrate the applications of physics to modern technology*, $34,000.00 NSF grant in collaboration with Prof. S. Ryan, Prof. R. Kantowski and Prof. G. Parker from Oklahoma University (1995).
- *Quantum Color Transparency and Nuclear Filtering*, Bhabha Atomic Research Center Young Scientist Award, 1996 (Rs. 500,000).
- Associate member, ICTP, Italy (1996-2001).
- *The cosmic anisotropy in the polarizations of radio waves from distant glaxies and the Corkscrew effect*, 1999-2002 (Rs. 700,00).
- *Precipitation Forecasting Using Neural Networks*, 2001-2003 DST (Rs. 450,000).
- *Study of large scale cosmic anisotropy in the radio and optical polarizations from active galactic nuclei and CMBR*, 2006-2009, DST (Rs. 1651000).
- *Standard Model with local scale invariance*, DST funded project, 2011-2013, (Rs. 15,93,600).
- *Large Scale Anisotropy in Universe*, 2017-2020, SERB (Rs. 2181520).