

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, 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 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_{Susy}^2/M_{Planck}^2 , where M_{Susy} is the scale of supersymmetry breaking.
- I introduced a new procedure to measure astronomical distances based on interferometry. This provides a direct method for measurement of astronomical distances and has the potential to directly measure cosmological distances in future.
- 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
Astrophysics
Electrodynamics

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, Bhubaneswar
Naveen K. Singh: currently visiting faculty at NIT, Jalandar
Pavan K. Aluri: currently faculty at BHU IIT, Varanasi

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

Gopal: currently faculty at Galgotias University

Sumeet Dagaonkar: currently employed with Quazar Technologies

Prabhakar Tiwari: currently postdoctoral fellow at NAOC, Beijing, China

Rahul Kothari: currently postdoctoral fellow at IIT Chennai

Alekha Chandra Nayak: currently postdoctoral fellow at PRL Ahmedabad

Shamik Ghosh: working on Cosmology

Ravindra K. Verma: working on particle physics

Khun Sang Phukon: working on gravitational waves

Paramita Dasgupta: working on Astro-Particle Physics

Prasenjit Sanyal: working on Particle Physics

Divya Rawat: working on x-ray binaries

Fahim Warsi: working on cosmic rays

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 galaxies 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).

Publications in Refereed Journals

Weak Lensing Effect on CMB in the Presence of a Dipole Anisotropy, (A. Agarwal, N. K. Singh and P. Tiwari), Eur. Phys. J. C79 no.7, 582 (2019).

Study of timing evolution from non-variable to structured large-amplitude variability transition in GRS 1915+105 using AstroSat (D. Rawat et al) Astrophys. J. 870, 4 (2019).

Evidence of isotropy on large distance scales from polarizations of radio sources (P. Tiwari), Astron.Astrophys. 622 A113, (2019).

Antarctic surface reflectivity calculations and measurements from the ANITA-4 and HiCal-2 experiments (S. Prohira et al) Phys. Rev. D 98, 042004 (2018).

Extensive broadband X-ray monitoring during the formation of a giant radio jet base in Cyg X-3 with AstroSat (M. Pahari et al) Astrophys. J. 853 (2018) 1, L11.

The top threshold effect in the $\gamma\gamma$ production at the LHC (S. Dugad, S. Mitra, P. Sanyal and R. K. Verma), EPJC 78, 715 (2018).

Phenomenological Implications of Very Special Relativity (A. C. Nayak), Phys. Rev. D 96, 075020 (2017).

Antarctic Surface Reflectivity Measurements from the ANITA-3 and HiCal-1 Experiments, (P. W. Gorham et al) J. Astron. Inst. 06, 1730002 (2017).

Testing the Isotropy of the Log Nlog S Slope for the NVSS Radio Catalog (S. Ghosh), Astrophys. J. 843, 13 (2017).

Probing statistical isotropy of cosmological radio sources using SKA, (S. Ghosh, G. Kashyap, R. Kothari, S. Nadkarni-Ghosh and P. Tiwari), J. Astrophys. Astron 37, 25 (2016).

Extracting Spectral Index of Intergalactic Magnetic Field from Radio Polarizations, (P. Tiwari), MNRAS 460, 2698 (2016).

Cosmological power spectrum in a noncommutative spacetime, (R. Kothari and P. K. Rath), Phys. Rev. D 94, 063531 (2016).

The Dirac Form Factor Predicts the Pauli Form Factor in the Endpoint Model, (S. Dagaonkar and J. Ralston), EPJC 76, 368 (2016).

Imprint of Inhomogeneous and Anisotropic Primordial Power Spectrum on CMB Polarization, (Rahul Kothari, Shamik Ghosh, Pranati K. Rath and Gopal Kashyap), MNRAS 460, 1577 (2016).

Dipole Modulation of Cosmic Microwave Background Temperature and Polarization (Shamik Ghosh, Rahul Kothari, Pranati K. Rath), JCAP 1601, 046 (2016).

Non-relativistic matter and Dark energy in a quantum conformal model (G. Kashyap and S. Mitra), Astroparticle Physics 75, 64 (2016).

The fine tuning of the cosmological constant in a conformal model, (G. Kashyap and S. Mitra), Int. Jour. of Mod. Phys. A. 30, 1550171 (2015).

Effect of VSR invariant Chern-Simon Lagrangian on photon polarization, (A. C. Nayak and R. K. Verma), JCAP 1507, 07, 031 (2015).

ELKO fermions as dark matter candidates, (B. Agarwal, S. Mitra, A. C. Nayak and R. K. Verma), Phys.Rev. D92 075027 (2015).

Noncommutative Geometry and the Primordial Dipolar Imaginary Power Spectrum, (P. Rath), EPJC 75, 113 (2015).

Relating the inhomogeneous power spectrum to the CMB hemispherical anisotropy, (P. Rath and P. Aluri), Phys. Rev. D 91, 023515 (2015).

Dipole Anisotropy in Integrated Linearly Polarized Flux Density in NVSS Data, (P. Tiwari), MNRAS, 447, 2658 (2015).

Dipole anisotropy in sky brightness and source count distribution in radio NVSS data, (P. Tiwari, R. Kothari, A. Naskar and S. Nadkarni-Ghosh) Astroparticle Physics **61**, 1 (2015).

Relating the cosmological constant and slow roll to conformal symmetry breaking, (G. Kashyap), Modern Physics Letters A **29**, 36 (2014).

Uncovering the Scaling Laws of Hard Exclusive Hadronic Processes in a Comprehensive Endpoint Model, (S. Dagaonkar and J. P. Ralston), EPJC **14**, 3000 (2014).

Testing the Dipole Modulation Model in CMBR, (P. Rath), JCAP 1312, 014 (2013).

Polarization Alignment in JVAS/CLASS flat spectrum radio surveys, (P. Tiwari), Int. J. of Mod. Physics, D22, 1304 (2013).

Direction dependence of the power spectrum and its effect on the Cosmic Microwave Background Radiation, (P. Rath, T. Mudholkar, P. Aluri and S. Panda), Journal of Cosmology and Astroparticle Physics, 1304, 007 (2013).

A flat space-time model of the Universe, Mod. Phys. Lett. A. 27, 1250201 (2012).

Cosmological implications of unimodular gravity, (A. Jaiswal, P. Karmakar, G. Kashyap, and N. K. Singh), Journal of Cosmology and Astroparticle Physics, 1211, 003 (2012).

Testing Unimodular Gravity, (P. Karmakar, S. Mitra, N. K. Singh, S. Panda), Journal of Cosmology and Astroparticle Physics, 1205, 020 (2012).

Parity Asymmetry in the CMBR Temperature Power Spectrum, (P. K. Aluri), Mon. Not. Roy. Ast. Soc. (MNRAS) **419**, 3378 (2012).

Large scale anisotropy due to pre-inflationary phase of cosmic evolution (P. K. Aluri), Mod. Phys. Lett. A **27**, 1250014 (2012).

A complete 3D numerical study of the effects of pseudoscalar-photon mixing on quasar polarizations, (N. Agarwal, P. K. Aluri, U. Khanna, P. Tiwari), Euro. Phys. Jour. C **72**, 1928 (2012).

Quantum Treatment of the Weyl Vector Meson, (S. Mitra, N. K. Singh, S. Panda), Phys. Rev. D **84**, 105037 (2011).

Cosmological Perturbation Analysis in a Scale Invariant Model of Gravity, (P. Karmakar, S. Mitra, N. K. Singh, S. Panda), Class. Quant. Grav. **28**, 215010 (2011).

Effect of Foregrounds on the cosmic microwave background radiation multipole alignment, (P. K. Aluri, P. Samal, J. P. Ralston), Mon. Not. Roy. Ast. Soc. (MNRAS) **414**, 1032 (2011).

Alignments in quasar polarizations: Pseudoscalar-photon mixing in the presence of correlated magnetic fields, (N. Agarwal, A. Kamal), Phys. Rev. **D83**, 065014 (2011).

New physics, the cosmic ray spectrum knee, and pp cross section measurements, (A. Dixit, D. W. McKay, P. Mukherjee), Eur. Phys. J. **C68**, 573 (2010).

Constraints on the Cosmological Constant due to Scale Invariance, (P. K. Aluri, S. Mitra, S. Panda, N. K. Singh), Mod. Phys. Lett. **A25**, 1349 (2010).

CMB Polarization and Temperature Power Spectra Estimation using Linear Combination of WMAP 5-year Maps, (P. Samal, R. Saha, J. Delabrouille, S. Prunet, T. Souradeep), The Astrophysical Journal **714**, 840 (2010).

Standard Model with Cosmologically Broken Quantum Scale Invariance (S. Mitra), Mod. Phys. Lett. A. **25**, 167 (2010).

Photon & Axion Oscillation In a Magnetized Medium: A General Treatment (Avijit K. Ganguly, Subhayan Mandal), Physical Review **D79**, 115014 (2009).

One Loop Calculation of Cosmological Constant in a Scale Invariant Theory (S. Mitra), Mod. Phys. Lett. A **24**, 2069 (2009).

Dark Energy and Dark Matter in General Relativity with local scale invariance (P. Aluri and N. K. Singh), Mod. Phys. Lett. A **24**, 1583 (2009).

Model Independent Foreground Power Spectrum Estimation using WMAP 5-year Data (T. Ghosh, R. Saha, T. Souradeep), Physical Review **D79**, 123011 (2009).

Signals of Statistical Anisotropy in WMAP Foreground-Cleaned Maps (Pramoda Kumar Samal, Rajib Saha, John P. Ralston), Mon. Not. Roy. Ast. Society (MNRAS) **396**, 511 (2009).

Signatures of Pseudoscalar Photon Mixing in CMB Radiation, (N. Agarwal, D. W. McKay, J. P. Ralston), Phys. Rev. **D 78**, 085028, (2008).

Two Photon Exchange Contributions to Elastic $e^- + p \rightarrow e^- + \vec{p}$ Process in a Nonlocal Field Formalism (S. D. Joglekar, S. Mitra), Eur. Phys. J. **C 57**, 671 (2008).

Direct determination of astronomical distances and proper motions by interferometric parallax, (J. P. Ralston), Astronomy & Astrophysics **484**, 887 (2008).

Cosmological Implications of a Scale Invariant Standard Model, S. Mitra, N. K. Singh, JCAP **0803**, 011 (2008).

Testing Isotropy of Cosmic Microwave Background Radiation, P. K. Samal, R. Saha, J. P. Ralston, Mon. Not. Roy. Ast. Society (MNRAS) **385**, 1718-1728 (2008).

CMB anisotropy power spectrum using linear combinations of WMAP maps, R. Saha, S. Prunet, T. Souradeep, Phys. Rev. **D78**, 023003 (2008).

The dynamical mixing of light and pseudoscalar fields, S. Das, J. P. Ralston, R. Saha, Pramana **70**, 439 (2008).

Two photon exchange contributions to elastic ep scattering in the nonlocal field formalism, (S. D. Joglekar, S. Mitra), hep-ph/0606149, Eur. Phys. J. **C52**, 339 (2007).

Self Interacting Dark Matter in the Solar System, (A. Ganguly, S. Mandal and S. Stokes), Phys. Rev. D **76**, 025026 (2007).

Cosmological Symmetry Breaking, Pseudo-scale invariance, Dark Energy and the Standard Model, (S. Mitra), Mod. Phys. Lett. **A22**, 1651 (2007).

Search for Global Metric Anisotropy in Type Ia Supernova Data, (M. Singh and J. P. Ralston), astro-ph/0510803, MPLA **22**, 1153 (2007).

A re-analysis of the three-year WMAP temperature power spectrum and likelihood, (Eriksen et al), Astrophys. J. **656**, 641 (2007).

Evading the astrophysical limits on light pseudoscalars, (S. Mandal), Int. J. Mod. Phys. **D 15**, 2095 (2006).

A blind estimation of the power spectrum of cmb anisotropy from wmap, (R. Saha and T. Souradeep), Astrophys. J. **645**, L89-L92 (2006).

Evidence for evolution or bias in host extinctions of high redshift supernovae, (J. P. Ralston), astro-ph/0506478, Astrophys. J. **637**, 91, (2006)

Interpretation of the global anisotropy in the radio polarizations of cosmologically distant sources, (S. Sarala), J. Astrophysics and Astronomy **27**, 443 (2006).

Supersymmetry and the Lorentz Fine Tuning Problem, (J. P. Ralston), Phys. Lett. **B621**, 213 (2005).

Probing Light Pseudoscalars with Light: Propagation, Resonance and Spontaneous Polarization, (S. Das, J. P. Ralston and R. Saha), JCAP **06**, 002 (2005).

Dark energy in an axion model with explicit $Z(N)$ symmetry breaking, Mod. Phys. Lett. **A20**, 1763 (2005).

Two Graviton Production at e^+e^- and Hadron Hadron Colliders in the Randall-Sundrum Model, (S. Panda), hep-ph/0401222, JHEP **0403**, 011 (2004).

The Virgo alignment puzzle in propagation of radiation on cosmological scales, (J. P. Ralston), Int. J. Mod. Phys. **D13**, 1857, (2004).

QCD Form Factors and Hadron Helicity Non-Conservation, (J. Ralston), hep-ph/0302043, Phys. Rev. **D69**, 053008 (2004).

Brane-Production and the Neutrino-Nucleon cross section at Ultra High Energies in Low Scale Gravity Models (Supriya Kar and Sukanta Panda), hep-ph/0201232, Int. J. Mod. Phys. **D12**, 1593 (2003)

Large Scale Alignment of Optical Polarizations from Distant QSOs using Coordinate Invariant Statistics, (Pankaj Jain, Gaurav Narain and S. Sarala), astro-ph/0301530, Mon. Not. Roy. Ast. Society (MNRAS) **347**, 394 (2004).

Electromagnetic Polarization Effects due to Axion Photon Mixing, (S. Panda and S. Sarala), hep-ph/0206046, Phys. Rev. D **66**, 085007 (2002).

Angular Dependence of Neutrino Flux in KM^3 Detectors in Low Scale Gravity Models, (Supriya Kar, Douglas W. McKay, Sukanta Panda, and John P. Ralston), hep-ph/0205052, Phys. Rev. D **66**, 065018 (2002).

Correlation of Ultra High Energy Cosmic Rays with Compact Radio Loud Quasars, astro-ph/0010235 (S. Bhattacharya, D. McKay, J. Ralston, S. Razzaque and A. Virmani), Astroparticle Physics **17**, 489 (2002).

Oscillating Color Transparency in $\pi A \rightarrow \pi p(A-1)$ and $\gamma A \rightarrow \pi N(A-1)$ (Bijoy Kundu and John P. Ralston), hep-ph/0005126, Physical Review D **65**, 094027 (2002).

Graviton Enhanced UHE Neutrino Cross Sections and Giant Air Showers, (A. Jain, D. W. McKay and J. P. Ralston), hep-ph/0011310, International Journal of Modern Physics A **17**, 533 (2002).

Short range SW monsoon rainfall forecasting over India using Neural Networks, (A. Kumar, P. Maini, and S. V. Singh), Mausam **53**, 225 (2002).

Polarized Electromagnetic Radiation from Spatially Correlated Sources (A. Agarwal, J. Rai), physics/9911073, Phys. Rev. E **64**, 066605 (2001).

A Circular Statistical Method for Extracting Rotation Measures, (S. Sarala), astro-ph/0007251, Mon. Not. Roy. Ast. Society (MNRAS) **328** 623 (2001).

Spectral dependence of Polarized light from spatially correlated sources (K. Bhuvalka), Physical Review E **64**, 36607 (2001), physics/0006004.

Cosmic Birefringence within the Framework of Heterotic String Theory, hep-ph/0011279, Int. Jour. of Mod. Phys. A **16**, 4011 (2001).

Perturbative Color Transparency in Electroproduction Experiments, (B. Kundu, J. Samuelsson, J. Ralston), Physical Review D **62** (2000) 113009.

Extra dimensions and Strong Neutrino-Nucleon interactions above 10^{19} eV : Breaking the GZK Barrier (D. W. McKay, S. Panda and J. Ralston), Phys. Lett. B **484**, 267 (2000).

Dynamical Gauge Symmetry Breaking in $SU(3)_L \otimes U(1)_X$ Extension of the Standard Model (P. Das), Phys. Rev. D **62**, 07500 (2000).

Covariant Symmetry Classifications for Observables of Cosmological Birefringence, (J. Ralston) International Journal of Modern Physics D **8**, 537 (1999).

Neutrino Absorption Tomography of the Earth's Interior using Isotropic Ultra-high Energy Flux (G. Frichter and J. Ralston), Astroparticle Physics **12**, 193 (1999).

Perturbative Proton Form Factor: Reexamined, (B. Kundu, H.N. Li and J. Samuelsson), European Physical Journal, **C 8**, 637 (1999).

Limits on Exotic Quarks in the $SU(3) \times U(1)$ Extension of the Standard Model from SUSY Search Data, (P. Das, D. W. McKay) Physical Review D **59**, 055011, 1999.

Anisotropy in the Propagation of Radio Polarizations from Cosmologically Distant galaxies, (J. Ralston), Mod. Phys. Lett. A14, 417 (1999).

New Phenomenon in Propagation of Radio Polarizations due to Magnetic Fields on Cosmological Scales, (B. Nodland and J. Ralston), Phys. Rev. Lett. **81**, 26 (1998).

Single Top from Technipion Production, (P. Baringer, D. McKay and L. Smith), Phys. Rev. D **56**, 2914 (1997).

Z' in the 3-3-1 model, (S. D. Joglekar), Phys. Lett. B **407**, 141 (1997).

Quantum Color Transparency and Nuclear Filtering (B. Pire and J. P. Ralston), Physics Reports **271**, 67 (1996).

Non-perturbative calculation of running masses and mixings (D. McKay and L. Smith), Mod. Phys. Lett. A **10**,773-787(1995).

Heavy Meson Radiative Decays and Light Vector Meson Dominance (A. Momen and J. Schechter), International Journal of Modern Physics A **13**, 2467 (1995).

Isospin Multiplet Structure in Ultra-Heavy Fermion Bound States (A. J. Sommerer, D. W. McKay, J. R. Spence, J. P. Vary and Bing-Lin Young), Phys. Rev. D. **49**, 2514 (1994).

$q\bar{q}$ bound states in the Bethe-Salpeter formalism, (H. Munczek), Phys. Rev. D **48**, 5403 (1993).

Systematic analysis method for color transparency experiments (J. Ralston), Phys. Rev. D **48**, 1104 (1993).

What Color Transparency Measures (J. Ralston), Phys. Rev. D **46**, 3807 (1992).

Strong Higgs Binding of the heavy fermion systems (D. McKay, A. Sommerer, J. Spence, Bing-Lin Young and J. Vary), Phys. Rev. D **46**, 4029 (1992).

On the validity of approximations for the calculation of the pion decay constant (H. Munczek), Phys. Lett. B **282**, 157 (1992).

Relativistic pseudoscalar bound states, results on Bethe-Salpeter wavefunctions and decay constants (H. Munczek), Phys. Rev. D **46**, 438 (1992).

Approach to color transparency in the soliton picture of the nucleon (J. Schechter, H. Weigel), Phys. Rev. D **45**, 1470 (1992).

Calculation of the pion decay constant in the framework of the Bethe Salpeter equation (H. Munczek), Phys. Rev. D **44**, 1873 (1991).

Applications of semiclassical techniques to sine Gordon theory: reexamined, Modern Physics Letters A **6**, 2509 (1991).

Poincare algebra and soliton energy in kink field theory, Modern Physics Letters A **6**, 2363 (1991).

Lorentz covariance of current matrix elements in a soliton model, Phys. Rev. D **44**, 3982 (1991).

Interpretation of the "quantum-stabilized Skyrmion" (J. Schechter, R. Sorkin) Phys. Rev. D **41**, 3855 (1990).

- Static properties of nucleon as a quantum stabilized soliton*, Phys. Rev. D **41**, 3527 (1990).
- Relativistic energy momentum relationship for a soliton*, Phys. Rev. D **41**, 3273, (1990).
- Neutron-proton mass splitting puzzle in Skyrme and chiral quark models* (R. Johnson, N. Park, J. Schechter, H. Weigel), Phys. Rev. D **40**, 855, (1989).
- Quantum stabilization of the Skyrme soliton* (J. Schechter, R. Sorkin), Phys. Rev. D **39**, 998, (1989).
- Aspects of the chiral quark model* (R. Johnson, J. Schechter), Phys. Rev. D **38**, 1571, (1988).
- Realistic pseudoscalar-vector meson Lagrangian and its solitonic excitations* (R. Johnson, N. Park, U. Meissner, J. Schechter), Phys. Rev. D **37**, 3252, (1988).
- Constraints on Bag Formation* (R. Johnson, J. Schechter), Phys. Rev. D **35**, 2230, (1987).
- Bag formation in a chiral model* (H. Gomm, R. Johnson, J. Schechter), Phys. Rev. D **33**, 3476, (1986).
- Scale anomaly and scalars* (H. Gomm, R. Johnson, J. Schechter), Phys. Rev. D **33**, 801, (1986).