Five Decades of Physics

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Cramer Symposium
September 11, 2009
1957-1969

- Non-Conservation of Parity in the Beta Decay of $^8$Li (Rice Univ., Sigma-Xi Award winning MA Thesis, 1959)
- Angular Correlation in the (a, a’ g) Reaction on Even-Even Nuclei (explained angle dependence) (Indiana University)
- Bringing the UW Tandem 3-Stage Tandem Van de Graaff and SDS-930 Online Computer System into operation (UW)
- Phase Correlations in Alpha Particle Inelastic Scattering (direct-reaction compound-nucleus competition) (UW)
- Isobaric Analogue Resonances in Closed-Shell Nuclei (UW)
1969-1979

- Inelastic Scattering to 1⁻ States through Isobaric Analogue Resonances (UW)
- Proposal, Design, and Construction of the UW Lamb-Shift Polarized Ion Source (UW)
- Polarized Proton Scattering through Isobaric Analogue Resonances (UW)
- Isospin Reactions with Heavy Ions (UW)
- \(^{12}\text{C}, ^{8}\text{Be}\) Transfer Reactions (U Munich, UW)
- Antimatter supernovas PRL (1977)
- Energy-Dependent Heavy Ion Elastic Scattering (global optical potentials) (UW, ORNL)
1979-1989

● Nuclear Rainbow Scattering with Heavy Ions and the “Notch-Test” (UW, LBNL, HMI-Berlin, MSU)

● Sub-Coulomb $^{16}$O Scattering and Wave-Equation Tests (UW)

● The Transition from Light to Heavy Ion Scattering (UW, LBNL, HMI-Berlin, MSU)

● The Transactional Interpretation of Quantum Mechanics (HMI-Berlin, UW)

● Begin writing bi-monthly “Alternate View” popular science columns for Analog Science Fiction/Fact Magazine (AV#01-36).

● Proposal, Design, and Construction of the UW Superconducting Booster (UW, 1984-1987)

● Hard SF Novel **Twistor** (Wm. Morrow, 1989)
1989-1999

- Experiment NA35 (LBNL, CERN)
- Experiment NA49 (MPI-Munich, CERN)
- Proposal, Design, and Construction of the STAR Experiment (UW, LBNL, BNL)
- Natural Wormholes & Gravitational Lensing (1995)
- Formation of the HBT Physics Working Group in STAR
- Theoretical investigations of HBT-related phenomena (MPI, UW)
- Nuclear Science Wall Chart & Teacher’s Manual (1997)
- Continue writing bi-monthly “Alternate View” popular science columns for Analog Science Fiction/Fact Magazine (AV#37-98)
1999-2009

- Theoretical investigations of HBT-related Phenomena
- Data Collection from the STAR Experiment (BNL)
- “Sound of the Big Bang” (2003)
- The HBT Analysis of STAR and NA49 Data
- The DWEF Model of Ultra-relativistic Heavy Ion Collisions
- Continue writing bi-monthly “Alternate View” popular science columns for Analog Science Fiction/Fact Magazine (AV#99-150)
- Quantum Optics and Retrocausality: Investigation of the Possibility of Nonlocal Quantum Communication with Momentum-Entangled Photon Pairs (1997-now)
Status of the UW Test of Nonlocal Quantum Communication with Momentum-Entangled Photon Pairs
Entanglement: The separated but “entangled” parts of the same quantum system can only be described by referencing the state of other part.

The possible outcomes of measurement $M_2$ depend on the results of measurement $M_1$, and vice versa. This is usually a consequence of conservation laws.

Nonlocality: This “connectedness” between the separated system parts is called quantum nonlocality. It should act even if the system parts are separated by light years. Einstein called this “spooky actions at a distance.”
Shih Ghost Interference Experiment (1995)
Klyshko Reflection

a)

Pump

b)

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Dopfer Position-Momentum EPR Experiment (1998)

LiIO$_3$ Down-Conversion Crystal

"Heisenberg" Lens $f = 86$ cm

Double Slit System $a = 75$ mm, $d = 255$ mm

"Heisenberg" Detector $D_1$

Note the use of coincidence.

Birgit Dopfer
PhD Thesis

Sept. 11, 2009
**Interference Detection**

**Mach-Zehnder Interferometer**

*MZ Advantages:* Interference with full incident beam.

*MZ Disadvantages:* extremely difficult to align (4 reflecting surfaces aligned to wavelength-scale precision); path is momentum-independent.
Periodically Poled Nonlinear Crystal

$\text{ppKTP} = \text{periodically poled KTiOPO}_4$

Phase Matching: $k_P = k_S + k_I + 2p/L$
The D-mirrors intercept and deflect one-half of each of the beams of entangled photons.
We have 10 km of high quality optical fiber coiled in the corner of the laboratory. We split the V-polarized entangled photon beam with a D-mirror, and pass each of the two paths of entangled photons through 10 km of fiber.

The H-polarized entangled photons have no optical delay, and the signal is received as soon as these photons are detected at $D_{1,2}$, which is about 50 ms before the signal is transmitted, when the twin entangled photons arrive at $D_{3,4}$.

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The End