Join the APS and DPB!

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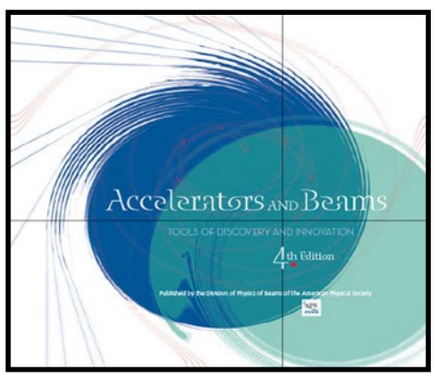

- The American Physical Society (APS) and its
  - ***Division of Physics of Beams*** (DPB)
    - "strengthen the resume; show commitment to our profession; path to future leadership roles"
- NA-PAC and IPAC conferences — the DPB provides:
- student support; childcare support; support for special conference (*e.g.*, Women in Science and Engineering (WISE); support for International Travel
- Outstanding Doctoral Thesis Research in Beam Physics Award
- free first-year trial memberships for students and subsequent reduced rate student membership and early career membership

Fundamentals: Review

- Tomorrow's Exam —
  - 2 hours: 9:30 a.m. to 11:30 a.m.
  - open books/notes
    - **class** textbook; self-written notes; class slides
    - can access slides from laptop, room computers
      - » NO internet searches allowed!
- Suggestions:
  - go through exam first; look for problems you know you can answer; then proceed to harder ones
  - don't leave anything unanswered (!?!)

- Lorentz Force
- Relativity — mc^2, W, E, v/c, E-p relation, …
- Magnetic Rigidity
- Bend Angle in a Magnetic Field
- Field of a Dipole Magnet
- Focal length of a “thin lens” Solenoid
- Focal length of a “thin lens” Quadrupole
- Field of a Quadrupole Magnet
- Hill’s Equation
  - Piecewise solutions — matrices
  - General solution
  - Amplitude function and phase advance

- Propagation of Courant-Snyder Parameters
  - drift
  - through a thin lens quadrupole
  - in general
- Beam Emittance
  - phase space area — conserved if no synch. rad.
  - in terms of “second moments”
  - transverse beam size in terms of emittance
- Longitudinal Considerations of Transverse Motion:
  - Dispersion Function
  - Momentum Compaction Factor

- Pill Box Cavity — resonant frequency
- Transit Time Factor
- Longitudinal Focusing
  - slip factor
  - evolution of dt, dW
  - bunching
  - adiabatic damping of transverse oscillations
- Repetitive Focusing Systems
  - Weak Focusing
  - Stability Criterion for Strong Focusing
  - Periodic Courant-Snyder Parameters

  - computation of Courant Snyder Parameters in a periodic system
  - periodic dispersion function
  - total beam size, with dispersion
- Repetitive Accelerating Systems
  - harmonic number
  - stable synchronous phase; rate of energy gain
  - difference equations and phase stability
  - synchrotron motion and synchrotron tune
  - adiabatic damping of synchrotron oscillations
  - transition and transition crossing
  - buckets/separatrix; longitudinal beam emittance

- Optics Modules
  - FODO cell
  - Achromat (esp. double-bend, single quad)
  - dispersion suppressors
- Sensitivity Analyses
  - betatron oscillation due to a steering error/ correction in a beam line
  - steering due to a misaligned quadrupole magnet
  - closed orbit distortion in a synchrotron
  - beta/alpha distortions due to gradient error
  - tune shift due to gradient error in a synchrotron
  - half-integer stop band

- Chromaticity
  - Use of sextuples to correct chromaticity
- Nonlinear Motion and resonances
  - tune variation with amplitude
  - separatrices; resonance islands; dynamic aperture
  - resonant extraction
  - sum and difference resonances — tune plots
- Synchrotron Radiation
  - power radiated from relativistic particle
  - damping of oscillations; damping times
  - quantum fluctuations and equilibrium beam sizeuse of wigglers and undulatory; FEL

- Injection mismatches and emittance dilution
- diffusion processes and emittance dilution
- Space Charge
  - tune shift in a synchrotron
  - beam-beam tune shift
- Wake Fields and Impedance
  - beam break-up
- Essential beam instrumentation
  - diagnostic techniques to determine beam properties, accelerator properties

- Also: Everything Else!!

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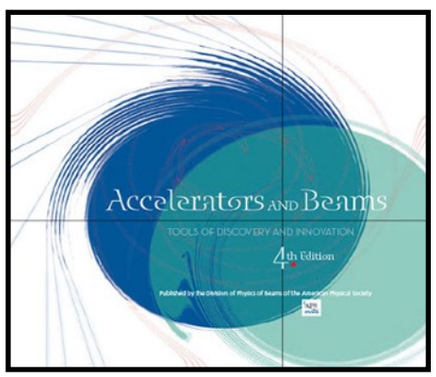

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