

# Recap 2<sup>nd</sup> Lecture

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**Matrix Formalism:** Each element  $i$  is represented by transfer matrix  $\mathbf{M}_i$ , trajectory from  $\vec{x} = \prod_{i=1}^n \mathbf{M}_i \cdot \vec{x}_0$

**Matrices (simple approx):** dipole and drift  $\mathbf{M}_D = \begin{pmatrix} 1 & L \\ 0 & 1 \end{pmatrix}$  quadrupole  $\mathbf{M}_Q = \begin{pmatrix} 1 & 0 \\ \pm 1/f & 1 \end{pmatrix}$

**Equations of Motion:**  $x''(s) + \left\{ \frac{1}{\rho^2(s)} - k(s) \right\} x(s) = \frac{1}{\rho(s)} \frac{\Delta p}{p_0}$  linearization of all terms  
 $y''(s) + k(s) y(s) = 0$

**Matrices from EQM:** build from solution of EQM for individual elements  $\rightarrow$  piecewise solution of EQM

**Transverse “Spaces”:** configuration space  $(x,y)$ , (horz.) trace space  $(x,x')$ , (horz.) phase space  $(x, p_x)$

**Beam Size & Divergence:** based on 2<sup>nd</sup> statistical moments:  $\sigma_x^2 = \overline{x^2}$ ,  $\sigma_{x'}^2 = \overline{x'^2}$

**(Geom.) Emittance:** area/ $\pi$  occupied by the beam in trace space, statistically defined by second moments  
 $\epsilon_x = \sqrt{\overline{x^2} \overline{x'^2} - \overline{x} \overline{x'}}$ ,  $\epsilon_y = \sqrt{\overline{y^2} \overline{y'^2} - \overline{y} \overline{y'}}$