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Nomenclature & Formulæ

This document has been produced by the Advisory and Programme Committee of the Joint Universities Accelerator School (JUAS), under the coordination of the School Director.

It has been agreed between the two Schools, CAS and JUAS, that it should serve as a guideline for the lectures presented both at the JUAS and CAS courses.

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Nomenclature & Formulæ

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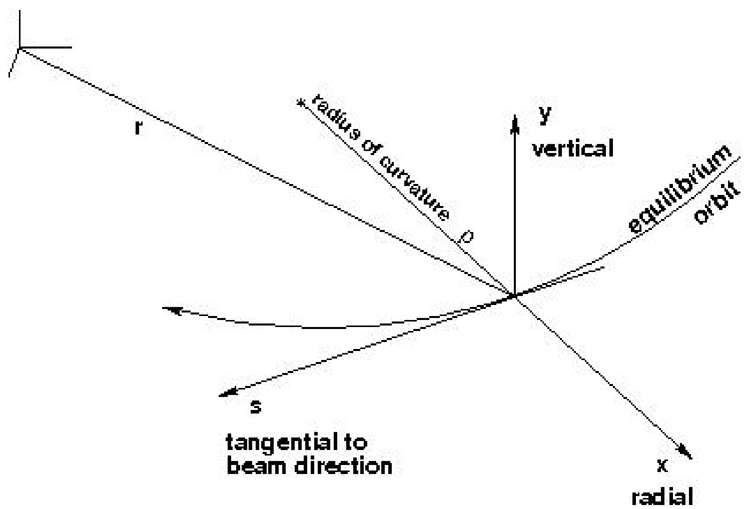
Local curvilinear, right-handed coordinate system (*x, y, s*) that follows the beam



Special symbols and conventions

Bold type	denotes a matrix or vector
$\|\mathbf{u}\|$	norm of vector **u**
Suffix $_0$	denotes a reference value, central orbit, rest mass etc.
Suffix $\perp$	denotes a transverse value
Suffix //	denotes a parallel value
$\dot{y}$	differentiation with respect to time, d/d*t*
y'	differentiation with respect to a specified variable, usually distance d/d*s*
$\bar{y}$	average value of a variable
<..>	average over a distribution
Δ_s	Small changes made to the synchronous ion by an RF device
Δ	Small differences between an ion and the synchronous ion
δ	Small changes caused by energy exchanges between an ion and an electrostatic field

d, ∂	absolute and partial differentials

Latin symbols

a	radius of inscribed circle defined by magnet poles or electrodes [m]
A_1, B_1, *etc.*	constants
$\boldsymbol{B}$, B_x etc.	magnetic induction [T]
c	speed of light [m s^{-1}]
C	Circumference of a ring lattice [m] ($C = 2\pi R$)
D_x, D_y	dispersion function [m]
e	unit electronic charge [As] or [C]
$\boldsymbol{E}$, E_x etc.	electric field intensity [Vm^{-1}]
E	total energy [eV].

(Note E_0 may be used for the rest mass energy and as electric field amplitude.)

$\boldsymbol{F}$	force [N]
f	frequency [s^{-1}]
g	full gap height in a dipole [m]
h	half gap height in a dipole or radius of inscribed circle in a lens [m]
h	harmonic number for an RF system = revolution period / RF period
k	normalised magnetic gradient ($k = -(|1/B\rho|) (dB_y/dx)_0$) [$m^{-2}$]
k_s	normalised magnetic skew gradient ($k_s = -(|1/B\rho|) (dB_x/dx)_0$) [$m^{-2}$]
K	general focusing constant [m^{-2}]
ℓ	length of an element <u>measured on the equilibrium orbit</u> [m]
L	characteristic length e.g, rectilinear length of a dipole [m]
m, m_0	mass and rest mass [kg]
m	modulation factor for the vanes of an RFQ. ($m = r_{max}/r_{min}$)
M	normalised solenoid field ($M = B_s/(B\rho)$) [m^{-1}]
m, n	integer indices
$\boldsymbol{p}$	momentum [eV/c]
Q_x, Q_y, Q_s	wave numbers
Q'	$\partial Q / \partial p/p$, chromaticity
q	charge ($q = ne$) [As] or [C]

r, θ , *s*	general cylindrical coordinates [m, rad, m]
R	average radius of curvature of a ring lattice [m]
s	axial distance coordinate[m]
t	time [s]
T	transit time factor
T	relativistic kinetic energy [eV]
U	potential function [V]
$\boldsymbol{v}$, v_x etc.	velocity [m s^{-1}]
V	electrode voltage [V]
x, y, s	local curvilinear coordinate system used for the beam [m]
X, Y, Z	survey coordinates [m]

Greek symbols

α_x, α_y, α_s	derivation of the Twiss beta function ($\alpha = -(1/2)d\beta/ds$)

(Note that the suffixes are often omitted for brevity. Note also that there are Twiss functions in the longitudinal plane.)

α_p	momentum compaction function
α, θ	angular deflection [rad]
β_x, β_y, β_s	Twiss betatron amplitude function [m]
β	ratio of particle speed to speed of light ($\beta = v/c$)
η	df/f / dp/p, phase slippage factor
γ_x, γ_y, γ_s	a Twiss function $\gamma = (1 + \alpha^2)/\beta$
γ	Lorentz parameter ($\gamma = m/m_0$)
ε_x, ε_y, ε_s	emittance [m rad], phase space area / π (calculated at 1-$\sigma_{x,y,s}$)
$\varepsilon_{x,n}$, $\varepsilon_{y,n}$, $\varepsilon_{s,n}$	normalised emittances [m rad]
ε	edge angle in 'hard-edge' model [rad]
ϕ	phase angle [rad]
ϕ_s	synchronous phase angle [rad]
Φ	potential function [V]
λ	wavelength [m]
Λ	propagation coefficient ($\Lambda = 2\pi/L$)

μ_x, μ_y, μ_s	Twiss phase advances [rad]
ρ	bending radius of trajectory [m]
$1/\rho$	curvature [m^{-1}]
$\sigma_x, \sigma_y, \sigma_s$ or σ_z	1-σ beam size
τ_x, τ_y, τ_s or τ_z	damping times
ξ	$\partial Q/Q \,/\, \partial p/p = Q'/Q$, chromaticity
ω	angular frequency ($\omega = 2\pi f$) [s^{-1}]
Ω, Ω_c	angular frequency and cyclotron frequency [s^{-1}]