**Eulerian vs. Lagrangian**

Lagrangian

Moving fluids tracking

Lagrangian displacement

Lagrangian velocity

Difficult to measure

Eulerian

Observing fixed points in space

Easy to measure in lab coordinates

Types of derivatives

1. Partial time derivative

𝛿/𝛿t f |x,y,z

Observing the variation of a function at fixed coordinates

1. Total time derivative

𝛿/𝛿t

𝛿c/𝛿t = (𝛿c/𝛿t)x,y,z + dx/dt (𝛿c/𝛿t)y,z + dy/dt (𝛿c/𝛿t)x,z + dz/dt (𝛿c/𝛿t)x,y

1. Substantial or material derivative

Dc/Dt = 𝛿c/𝛿t + vx𝛿c/𝛿x + vy𝛿c/𝛿y + vz𝛿c/𝛿z

Dc/Dt = 𝛿c/𝛿t + v\*▽c

Relationship between Lagrangian & Eulerian

1. F(**x**p, t)
2. **xp(t)** + **v**p𝛿(t)

Fxn = F(xp + vp𝛿t, t +𝛿t)

Df/Dt = lim𝛿t-->0 (F(**xp**+ **v**p𝛿t, t + 𝛿t) - F(**xp**, t))/𝛿t

Change in a property that is observed by the moving particle.

Taylor Series Expansion

F(x,y) = F(a,b) + (x-a)Fx(a,b) + (y-b)Fy(a,b)

F(**xp**+ **v**p𝛿t, t + 𝛿t) = F(**xp**, t) + 𝛿(t)d/dt F(**xp**, t) + **vp**𝛿t▽F(**xp**,t) + ... (0)

DF/Dt = 𝛿/𝛿t F + v▽F