dm
Adx
??
x
x
$F(x) =$
$Ap(x)$
$x+$
dx

$$F(x+dx) = -Ap(x+dx) = -A[p(x)+\frac{\partial p}{\partial x}dx].$$

$-x$
x
dm

$$dF_x = F(x)+F(x+dx) = A\left[p(x) - p(x) - \frac{\partial p}{\partial x}dx\right] = -A\frac{\partial p}{\partial x}dx.$$

dm

$$dF_x = -A\frac{\partial p}{\partial x}dx = \frac{\partial v_x}{\partial t}dm = \rho_0 A\frac{\partial v_x}{\partial t}dx$$

ρ_0
ρ
y
z

$$\vec{\nabla} p = -\rho_0\frac{\partial \vec{v}}{\partial t}.$$

(1)

V
V

$$\frac{\partial m}{\partial t} = \frac{\partial}{\partial t}\int_V \rho\, dV = \int_V \frac{\partial \rho}{\partial t} dV$$

$$\Phi_m = -\rho_0 \oint_A \vec{v}\cdot d\vec{A} = -\rho_0 \int_V (\vec{\nabla}\cdot\vec{v})\, dV.$$

$$\frac{\partial \rho}{\partial t} = -\rho_0(\vec{\nabla}\cdot\vec{v})$$

(2)

$\delta Q =$
$nC_V dT+$
$pdV =$
0
$pdV+$
$Vdp =$
$nRdT$

$$(R+C_V)pdV+C_V V dp = 0 \text{ or } \gamma\frac{dV}{V}+\frac{dp}{p} = 0 \text{ with } \gamma \equiv \frac{R+C_V}{C_V} = \frac{C_p}{C_V}.$$

$\gamma\frac{d(m/\rho)}{m/\rho}+$
$\frac{dp}{p} =$
$-\gamma\frac{m}{\rho^2}\frac{d\rho}{m/\rho}+$
$\frac{dp}{p} =$
$-\gamma\frac{d\rho}{\rho}+$
$\frac{dp}{p} =$
0

$$\frac{dp}{p_0} = \gamma\frac{d\rho}{\rho_0}$$

(3)

ρ_0
p_0
??
??

$$\frac{\partial p}{\partial t} = -p_0\gamma\left(\nabla\cdot\vec{v}\right).$$

(4)

??
$\frac{\partial^2 p}{\partial t^2} =$
$c^2\Delta p$
$c \equiv$
$\sqrt{\frac{p_0\gamma}{\rho_0}}$
$i(\vec{r}\cdot-\omega t)$
$=$
$e^{i(\vec{r}\cdot-\omega t)}$
$=$
$e^{i(\vec{r}\cdot-\omega t)}$

$$\|\| = \|\| = \frac{\omega}{c_1} \text{ and } \|\| = \frac{\omega}{c_2}$$

c_1
c_2
$+ =$

$$R_I = \frac{I_{ref}}{I_{in}} = \frac{p^2_{ref,rms}}{Z_1}\frac{Z_1}{p^2_{in,rms}} = R_p^2 \text{ and } T_I = \frac{I_{tr}}{I_{in}} = \frac{p^2_{tr,rms}}{Z_2}\frac{Z_1}{p^2_{in,rms}} = T_p^2 \frac{Z_1}{Z_2}.$$

$Z_1 \ll$
Z_2
$T_p \approx$
2
T_I
?

$$\alpha(\theta_{in}) = 1 - |R_p(\theta_{in})|^2 . \quad (5)$$