18.311: Principles of Applied Mathematics Lecture 29

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Show equivalent to wave equation:

Eliminate either R or u. Better yet, introduce velocity potential:

$$u = \varphi_x$$
 and $(a_0^2/\rho_0)*R = -\varphi_t$

Note this is the pressure perturbation.

Hence, second equation is satisfied. Then first equation gives

$$\phi_{tt}$$
 - $a_0^{2*}\phi_{xx}$ = 0. Wave equation.

Note boundary conditions:

- Closed pipe: $\phi_x = 0$.
- Open pipe: $\phi = 0$.

Give other examples where these boundary conditions occur:

- Shallow water: Closed and open channel.
- String equation: Free end and clamped.

Using the solution above for gas-dynamics, we see that

$$\Phi = F(x-a_0^*t) + G(x+a_0^*t),$$

where $F' = (1/2)^* f$ and $G' = (1/2)^* g$.

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