**§10. Shock Discontinuity (Shock Wave)**

When mass flow occurs across a discontinuity (≠ 0, α = 1, 2), it follows from mass conservation equation (3.9.29) that the normal velocities *vknk* in discontinuity-fixed coordinates (i.e.,  and ) have the same sign on opposite sides of the surface. If the direction of the normal **n** at point P (from region *1* to region *2*, see Fig. 3.9.1) is chosen such that both  and  are negative, then the mass flow is from *1* to *2* (ξ > 0, see text around Eq. (3.9.27)). In other words, when the regions on opposite sides of a discontinuity are referred to by superscript (1) and (2) so that both  and  are negative, the medium in region *1* is ahead of the discontinuity while the medium in region *2* is behind it (i.e., the particles in region *2* have crossed the surface).

***Definition.*** A surface across which the normal velocity of the medium is discontinuous ([*vn*] ≠ 0, ξ ≠ 0), and therefore so is the normal stress ([σ*nn*] ≠ 0), is called a *shock wave*, a *shock*, or a *shock discontinuity*.

A shock discontinuity cannot be a contact one. Indeed, consider the component of momentum balance (3.9.30) along the normal **n**,

ξ = − [σ(*nn*)] or ρ(1) ( – *D*) [*vn*] = [σ(*nn*)]. (3.10.1)

It is clear from [*vn*] ≠ 0 that  ≠ . Then, using the mass balance ρ(1) = ρ(2) and noting that ρ′(α) ≠ 0 (α = 1, 2), we find that  ≠ 0, and hence  ≠ *D* (α = 1, 2). Therefore, [σ*nn*] ≠ 0 and there is always a flow of matter across a shock discontinuity.

A shock discontinuity is either a *compression shock* or a *rarefaction* *shock* (*expansion shock*), depending on whether density increases or decreases across the shock in the direction of motion of the medium. If  and  are negative, then ρ(2) > ρ(1) and ρ(2) < ρ(1) for compression and rarefaction shocks, respectively.

**Derivation of shock jump relations based on analysis of particle motion.** Balance of equations across a discontinuity can be derived not only from integral

*Отсутствует основная часть Главы 3.10*