Furthermore, if the nature of incident sound wave is such as to cause the air molecules within the infinitesimal volume element V_o to collectively move in a given direction, *i.e*. to be displaced by a collective 3-D distance $\vec{\xi}(\vec{r},t)$ from its equilibrium position, with collective velocity $\vec{u}(\vec{r},t)$ and collective acceleration $\vec{a}(\vec{r},t)$, the "magical" Gaussian surface S_o co-moves with the air contained within V_o.

An infinitesimal volume element of size *e.g*. a cubic micron $V_o = 1(\mu m)^3$ is statistically large enough for our purposes. The air contained within this infinitesimal volume element V_o is in thermal equilibrium with itself and with the air surrounding it. Avogadro's number $N_A = 6.022\times10^{23}\, molecules/mole$ and recall that one mole of {bone-dry} air @ NTP has mean/average molar mass of $m_{mol}^{air} = 28.97\, gms/mole$. Thus, for a volume mass density of air $\rho_o = 1.204\, kg/m^3$ at NTP there are $24.06\ cm^3/mole$, or ~ 25 *billion* molecules of air per cubic micron at NTP. The average/mean velocity vector associated with the mean/average thermal energy $\langle U_{th}(\vec{r},t)\rangle$ of this number of air molecules contained within the infinitesimal volume element V_o is $\langle \vec{u}_{mol}(\vec{r},t)\rangle = 0$, however the thermal energies $\langle E_{mol}^{th}\rangle = \frac{3}{2}k_B T = \frac{1}{2}m|\vec{u}_{mol}|^2$ associated with individual air molecules contained within V_o may be such that individual molecules within V_o leave through the bound surface S_o via exiting through one of the top, bottom or side surfaces associated with S_o. However, one of the other "magical" properties endowed with the co-moving surface S_o associated with the air contained within the infinitesimal volume element V_o is that if an air molecule leaves (enters) the bounding surface S_o at a given point $\vec{r}_{mol}$ on one side of the volume element with velocity vector $\vec{u}_{mol}(\vec{r}_{mol},t)$, it instantaneously enters (leaves) the surface S_o again with velocity vector $\vec{u}_{mol}(\vec{r}_{mol}^{\,conj},t)$, but on the other side of the volume element, at its conjugate point $\vec{r}_{mol}^{\,conj}$ relative to the center point $(\vec{r},t)$ of the infinitesimal volume element, V_o. Thus the total air mass m_{air}, the average/mean linear momentum $\langle \vec{P}_{air}(\vec{r},t)\rangle$ and the average/mean thermal energy $\langle U_{th}(\vec{r},t)\rangle$ are all conserved by this "magical" property of the fictitious Gaussian surface *S* bounding the infinitesimal volume element V_o.

From Newton's 2nd law of motion, $\vec{F}_{net} = m\vec{a}$, we can calculate the force(s) acting on the air within the infinitesimal volume element *V* due to an over-pressure amplitude $p(\vec{r},t)$. The mass of air contained within the infinitesimal volume element V_o is $m = \rho_o V_o\ (kg)$. Newton's 2nd law tells us that $\vec{F}_{net}(\vec{r},t) = m\vec{a}(\vec{r},t)$ or that: $\vec{a}(\vec{r},t) = \vec{F}_{net}(\vec{r},t)/m = \vec{F}_{net}(\vec{r},t)/\rho_o V_o$. We define the {net} force per unit volume acting on the infinitesimal volume element as: $\vec{f}_{net}(\vec{r},t) \equiv \vec{F}_{net}(\vec{r},t)/V_o$. Thus the acceleration $\vec{a}(\vec{r},t) = \vec{f}_{net}(\vec{r},t)/\rho_o$.

Next, let us (initially) consider only the *x*-component of the net force due to an over-pressure $p(\vec{r},t)$ acting on the infinitesimal volume element V_o of air, as shown in a side view in the figure below: