$$Q_{bound}^{pair} = \left(Q_{bound}^{pair}\right)_{tr} \frac{4\pi^2}{h^5} \int_{H<0} \exp\left(-\frac{\mathcal{H}}{kT}\right) dR\, d\theta\, dp_R\, dp_\theta\, dJ_x\, dJ_y\, dJ_z$$

$$\int_{-\infty}^{\infty} f(x)dx = \left[y = \frac{1}{\pi}\arctan x + \frac{1}{2}, dy = \frac{1}{\pi}\frac{dx}{1+x^2}, dx = \pi(1+x^2)dy\right] = \pi \int_0^1 (1+x^2) f(x)dy,$$

gather where x relates to y the following way

$$x = \tan\left(\pi\left(y - \frac{1}{2}\right)\right)$$