connecting $\mathbf{a}'$s or $\mathbf{b}'$s on two different strings. Let us suppose that $\mathbf{a}'$ jumps from $\mathbf{a}'_-$ to $\mathbf{a}'_+$ at a kink. Then the "sharpness" of a kink is defined by

$$\psi = \frac{1}{2}(1 - \mathbf{a}'_+ \cdot \mathbf{a}'_-). \tag{7}$$

Thus the norm of the difference between $\mathbf{a}'_-$ and $\mathbf{a}'_+$ is $|\Delta\mathbf{a}'| = 2\sqrt{\psi}$. The production rate of kinks is given by [13]

$$\dot{N}_{\rm production} = \frac{\bar{\Delta}V}{\gamma^4 t^4} g(\psi), \tag{8}$$

where $N(t,\psi)d\psi$ denotes the number of kinks with sharpness between ψ and $\psi + d\psi$ in the volume V, $\bar{\Delta}$ and γ are constants related to string networks, whose values are [13],

$$\bar{\Delta}_r \simeq 0.20,\ \bar{\Delta}_m \simeq 0.21,\ \gamma_r \simeq 0.3,\ \gamma_m \simeq 0.55, \tag{9}$$

Here the subscript $r(m)$ denotes the value in the radiation(matter)-dominated era.

$$g(\psi) = \frac{35}{256}\sqrt{\psi}(15 - 6\psi - \psi^2) \tag{10}$$

and we set $g(\psi) = 0$ for $\psi < 0, 1 < \psi$. The correlation length of the cosmic strings ξ is given by $\xi \simeq \gamma t$.

Produced kinks are blunted by the expansion of the Universe. The blunting rate of the kink with the sharpness ψ is given by [13]

$$\left.\frac{\dot{\psi}}{\psi}\right|_{\rm stretch} = -2\zeta t^{-1}, \tag{11}$$

where ζ is a constant which, in the radiation(matter)-dominated era, is given by $\zeta_r \simeq 0.09$ ($\zeta_m \simeq 0.2$).

On the other hand, the number of kinks on an infinite string decreases when it self-intercommutes since some kinks are taken away by the loop produced. The decrease rate of kinks due to this effect is given by [13]

$$\left.\frac{\dot{N}}{N}\right|_{\rm to\ loop} = -\frac{\eta}{\gamma t}, \tag{12}$$

where η is constant which, in the radiation(matter)-dominated era, is given by $\eta_r \simeq 0.18$ ($\eta_m \simeq 0.1$).

Taking into account these effects, the evolution of the kink number N obeys the following equation,

$$\dot{N} = \frac{\bar{\Delta}V}{\gamma^4 t^4} g(\psi) + \frac{2\zeta}{t}\frac{\partial}{\partial\psi}(\psi N) - \frac{\eta}{\gamma t} N. \tag{13}$$