Galaxy collision & star collision

Please note: the calculations below merely yield a rough indicative estimate.

Suppose a galaxy consisting of equidistant sun-like stars in a cubic lattice with an interstar distance: D

yielding a star density of: $\rho_{\text{star}} = \frac{1}{D^3}$

Now suppose two such galaxies collide.

During that occurrance, the star density doubles: $\rho_{\text{coll}} = \frac{2}{D^3}$

For comparison, we consider a gas, although stars behave differently. Under normal circumstances, gas molecules frequently collide. In air at room temperature, each molecule undergoes over 7 billion (NL: 7 miljard) collisions per second. Between two successive collisions, each molecule travels in uniform motion along a straight line, in agreement with Sir Isaac Newton's first law, the law of inertia (which actually comes from Galileo Galilei). This intercollision distance is called the free path length.

The *mean* free path length is given by: $\ell = \frac{1}{\rho\sigma\sqrt{2}}$

where σ is the so-called cross section, the effective projected surface area for collisions.
For spherical objects of the same size, it equals π times the diameter squared.

The cross section of the sun then equals: $\sigma_{\odot} = \pi(2R_{\odot})^2 = 4\pi R_{\odot}^2$

which for a galaxy collision renders: $\ell = \frac{1}{\rho_{\text{coll}} \cdot \sigma_{\odot} \cdot \sqrt{2}} = \frac{D^3}{2 \cdot 4\pi R_{\odot}^2 \sqrt{2}} = \frac{1}{8\pi\sqrt{2}} \cdot \frac{D^3}{R_{\odot}^2}$

Our own neighbourhood in the Milky Way has: $D \approx 5$ ly $\approx 4.73 \times 10^{16}$ m
and the solar radius equals: $R_{\odot} = 6.96342 \times 10^8$ m
which yields a mean free path length of: $\ell \approx 6.14 \times 10^{30}$ m
$\ell \approx 6.49 \times 10^{14}$ ly
$\ell \approx 47133 D_{\text{H}}$

This is nearly *fifty thousand* times the Hubble distance, the latter being the size of the entire cosmos!
If the colliding galaxies' mutual velocity equals v,
the timespan between 2 successive star collisions is: $\Delta t = \ell / v$

The duration of the galaxy collision would at most equal the sum of their diameters, divided by v,
yielding a galaxy collision duration of: $\Delta T = \frac{2\varnothing}{v}$

The probability of a single star to collide then equals: $P_{\text{coll}} = \frac{\Delta T}{\Delta t} = \frac{2\varnothing}{\ell}$

The diameter of the Milky Way roughly equals: $\varnothing_{\text{MW}} \approx 10^5$ ly $\approx 9.46 \times 10^{20}$ m

which renders: $P_{\text{coll}} \approx \frac{2 \cdot 9.46 \times 10^{20}}{6.14 \times 10^{30}} \approx \frac{1}{3.25 \times 10^9}$

Probabilty for a single star to collide with another one: roughly 1 in 3 billion (NL: 1 op 3 miljard).
The Milky Way contains roughly: 2×10^{11} stars,
yielding a total star collision count of: 62 .

We could have calculated with the Roche limit (where tidal forces make objects go to smithereens) instead of the physical radius. If both objects have the same mass density, this Roche limit roughly equals $2.44R$. It would decrease the mean free path by a factor of $(2.44)^2 \approx 6$, raising the no. of star collisions by the same. Let's round it to:

Total destructive star collision count during a galaxy collision: < 500 .

BUT... for planets orbiting a star, an inevitable catastrophe would already occur way before another star comes within the Roche limit. Most probably, gravitational effects would totally mess up the entire arrangement. Any form of life on such planets would very plausibly be completely terminated. Hasta la vista, baby! One should use at least the size of the planetary system to calculate the cross section. Neptune's orbital radius of $6472R_{\odot}$ would render $62 \cdot 6472^2 \approx 2.6 \times 10^9$ destructive events. For a single planetary system, the chance of ruination then approximates $(2.6 \times 10^9)/(2 \times 10^{11}) = 1.3\%$.

Who told you stars will not clash during a galaxy collision? All hell breaks loose!