# Derivation of the Bell probability density expression

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## Unfolding

Let be the probability that a protein molecule is still folded at time *t* pulling force .

The unfolding rate for a folded protein is defined by

Let and (i.e. the protein is known to be folded at zero force). Assume that the pulling force increases at a constant rate . Then, at :

At later times (and higher ) we mut consider that the probability the protein is still unfolded has diminished to , so we get

Rearranging:

Integrating from S = 1, F = 0 to S, F:

Exponentiating both sides:

Let be the probability density of unfolding at force . Then

Differentiating, we get

Bell’s expression for unfolding rate is:

Plugging this into the expression for:

The integral in the ex

So can be written:

## Refolding

The refolding probability increases as the pulling fore decreases, so the Bell refolding rate has the form

For the relaxation trace, . Let S now be the probability that the protein is **un**folded. If we know that the protein is unfolded at force , we integrate from S = 1, F = F0 to S, F:

Bell:

The integral can be written

In practice, even in the case of a late rip, the last exponential is very close to zero, so

Defining this can be written