**Lemma**: Given a drifted Brownian motion  . Define

Then

**Proof**:

We determine the law of . According to the Proposition 10.4 of (Privault, 2023)

Then, it is easy to deduce the density function of

Return to the expectation, we have

The integrand is like the density function of the hitting time which is defined by

So, according to the Proposition 10.4 of (Privault, 2023), the integral is exactly the probability

Then