 ICCES, vol.13, no.3, pp.53-53

# Fractional diffusion-advection and pattern formations of MinE Protein dynamics in *Escherichia coli*: experiments and theories

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## Summary

How does a cell successfully divide is one of very fundamental questions in biological and medical science especially concerning mechanism. With this regards, MinE proteins are very important for *Escherichia coli cell* division process because it supports FtsZ proteins to form at mid-cell which lead to cell division at that region. In this work, we quantitatively studied the physical properties of MinE protein clusters including pattern formations and dynamic motions using both theoretical and experimental approach. Experimentally, through the spot tracking technique (STT) and diffusion analysis, it was found that MinE globally performed oscillatory motion from middle cell to the polar zone. Locally, the spatial distribution was observed to be the normal distribution which MinE mostly likely to move near the midcell zone (approximately 50% of cell length). Surprisingly, we also found that the anomalous diffusive motion of MinE proteins between midcell and polar zone came out the fractional diffusion-advection with the dynamics exponents are approximately $\alpha \sim 0.44 \pm 0.25$ and the velocity field are approximately $0.028 \pm 0.018$ $\mu$m/s. Physical and biological discussions were given. It is reasonable to say that this quantitative information could contribute to an improvement of the dynamic model of the protein oscillation. Our findings reveal more understandings about protein motions which play an important part in their function.

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