SEMINÁRIO DE EQUAÇÕES DIFERENCIAIS PARCIAIS

Chemotaxis and Reactions in Anomalous Diffusion Dynamics

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05/06/2025 (Quinta - Feira)

16:00 horas

Sala 321 do IMECC

Resumo: Chemotaxis – the directed movement of cells or organisms in response to chemical gradients – is a key mechanism in many biological processes, often intertwined with reaction dynamics. In particular, chemotaxis can significantly enhance and sustain reactions.

While the classical Keller-Segel model [4] have been widely used to study chemotaxis under standard diffusion assumptions, it fails to capture essential features in environments where chemoattractants, food, or other targets are sparse or rare. In such cases, anomalous diffusion – the superdiffusive type – offers a more accurate description of cellular behavior, accounting for the long-range, nonlocal interactions exhibited by motile cells [2, 3].

Motivated by this, we considered a modified Keller-Segel-type equation for a single density function, incorporating advection, absorbing reactions, and superdiffusive behavior via the fractional Laplacian. Within this framework, we studied how chemotactic attraction influences processes such as reproduction (broadcast spawning) in the context of anomalous diffusion of gamete densities, extending the analysis initiated by [5].

The talk is based on joint work with Alexander Kiselev (Duke University), as detailed in [1].

References

[1] C. Andrade and A. Kiselev. *Chemotaxis and Reactions in Anomalous Diffusion Dynamics*. 2024, arXiv: 2412.19940

[2] C. Escudero. "The fractional Keller-Segel model". In: *Nonlinearity* 19.12 (2006), pp. 2909-2918.

[3] , G. Estrada-Rodriguez, H. Gimperlein, and K. J. Painter. "Fractional Patlak-Keller-Segel equations for chemotactic superdiffusion"'. In: *SIAM J. Appl. Math.* 78.2 (2018), pp. 1155-1173.

[4] E. F. Keller and L. A. Segel. "Initiation of slime mold aggregation viewed as an instability". In: *J. Theoret. Biol.* 26.3 (1970), pp. 399-415.

[5] A. Kiselev and L. Ryzhik. "Biomixing by chemotaxis and enhancement of biological reactions". In: *Comm. Partial Differential Equations* 37.2 (2012), pp. 298-318.