Degenerate Bifurcations in Binary-Mixture Convection

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ABSTRACT

Binary-Mixture convection, also known as Soret convection, is a rich source of patterns and complex dynamics. Its study has received much attention, in particular in the configuration in which the fluid is heated from below. In that case, besides of the aforementioned patterns, there is a transition from steady to oscillatory instabilities, described as a codimension-two bifurcation for finite containers. This transition occurs for a value of the separation ratio (S) a parameter related to the buoyancy ratio (thermal vs. solutal) and the Soret coefficient.

In a lateral heating configuration, previous studies indicate that there is a marked transition between the pure fluid case [1] ($S = 0$) and the $S = -1$ case [2], concerning the symmetry of the instabilities as well as its temporal dynamics. In an effort to shed some light into this transition, previous works [3] uncovered a rich variety of codimension-two points changing the nature of the global bifurcations found for $S = -1$.

The scenario found in [3] for low Rayleigh number presented an association of codimension-two bifurcations that was also found in many other problems. It was conjectured that this association was related with a higher codimension bifurcation, in particular the Dumortier-Roussarie-Sotomayor bifurcation.

Here we present a comprehensive study of the transition from $S = -1$ to $S = 0$, without restricting it to the low Rayleigh case. To begin with, the transition from non-symmetric to symmetric instabilities is clearly elucidated, and for certain values of S exotic structures such as isolas are found in the bifurcation diagram.

Also, as in [3], another association of codimension-two bifurcations is found. In this case, the proximity of the bifurcation points seems to suggest the close presence of another degenerate bifurcation. We identify the corresponding codimension-three bifurcation as a degenerate pitchfork-Hopf interaction [4] and provide its bifurcation diagram.

REFERENCES

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