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Modeling active fluids via physically constrained machine learning[1] MATTHEW GOLDEN, JYOTHISHRAJ NAMBISAN, ALBERTO FERNANDEZ-NIEVES, Georgia Inst of Tech, ROMAN GRIGORIEV, Georgia Institute of Technology — Active matter is abundant on Earth, especially in living systems, with examples ranging from cell-division to bacterial suspensions. We investigate a particular example of active matter – a fluid driven by chemically-driven molecular motors acting on a suspension of microtubules. Its dynamics should be described by a model including a pair of coupled partial differential equations: one governing the fluid flow and another governing the orientation of microtubules. These equations must capture all relevant forces and torques acting on the two components, both described by tensor fields. Deriving these equations from first principles is difficult, as interactions occur over many length and time scales and not all the relevant physical processes are understood. A data-driven model discovery offers a promising alternative. We use a hybrid approach which combines general physical constraints such as locality, causality, and symmetries to construct a library of candidate models with symbolic regression to narrow it down. We show that this approach allows a parsimonious model of the system to be derived from experimental recordings.

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