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Theory of Star Formation

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We review current understanding of star formation, outlining an overall theoretical framework and the observations that motivate it. A conception of star formation has emerged in which turbulence plays a dual role, both creating overdensities to initiate gravitational contraction or collapse, and countering the effects of gravity in these overdense regions. The key dynamical processes involved in star formation -- turbulence, magnetic fields, and self-gravity -- are highly nonlinear and multidimensional. Physical arguments are used to identify and explain the features and scalings involved in star formation, and results from numerical simulations are used to quantify these effects. We divide star formation into large-scale and small-scale regimes and review each in turn. Large scales range from galaxies to giant molecular clouds (GMCs) and their substructures. Important problems include how GMCs form and evolve, what determines the star formation rate (SFR), and what determines the initial mass function (IMF). Small scales range from dense cores to the protostellar systems they beget. We discuss formation of both low- and high-mass stars, including ongoing accretion. The development of winds and outflows is increasingly well understood, as are the mechanisms governing angular momentum transport in disks. Although outstanding questions remain, the framework is now in place to build a comprehensive theory of star formation that will be tested by the next generation of telescopes.

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