P53a Magnetically Regulated Star Formation in 3D: The Case of Taurus Molecular Cloud Complex

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We carry out three-dimensional MHD simulations of star formation in turbulent, magnetized clouds, including ambipolar diffusion and feedback from protostellar outflows. The calculations focus on relatively diffuse clouds threaded by a strong magnetic field capable of resisting severe tangling by turbulent motions and retarding global gravitational contraction in the cross-field direction. They are motivated by observations of the Taurus molecular cloud complex (and, to a lesser extent, Pipe Nebula), which shows an ordered large-scale magnetic field, as well as elongated condensations that are generally perpendicular to the large-scale field. We find that stars form in earnest in such clouds when enough material has settled gravitationally along the field lines that the mass-to-flux ratios of the condensations approach the critical value. Only a small fraction (of order 1% or less) of the nearly magnetically-critical, condensed material is turned into stars per local free-fall time, however. The slow star formation takes place in condensations that are moderately supersonic; it is regulated primarily by magnetic fields, rather than turbulence. The quiescent condensations are surrounded by diffuse halos that are much more turbulent, as observed in the Taurus complex. Strong support for magnetic regulation of star formation in this complex comes from the extremely slow conversion of the already condensed, relatively quiescent $C^{18}O$ gas into stars, at a rate two orders of magnitude below the maximum, free-fall value. We analyze the properties of dense cores, including their mass spectrum, which resembles the stellar initial mass function.