Rotational Acceleration During Stellar Collapse: Red Dwarfs Evolving into Brown Dwarfs under Stellar Metamorphosis

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Abstract

Brown dwarfs exhibit extremely high rotation rates despite their small radii and faint luminosities. Conventional astrophysics treats them as "failed stars," but within the framework of *Stellar Metamorphosis (SM)* they are understood as **older, contracting stellar remnants** — the natural continuation of red dwarf evolution. As stars lose mass and shrink, their angular momentum becomes concentrated into a smaller body, increasing rotational energy. This paper outlines how SM explains the emergence of rapidly rotating brown dwarfs as an ordinary phase in stellar aging and collapse.

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1. Introduction

Observations of ultrafast-rotating brown dwarfs, such as **2MASS J12195156+3128497** (rotation period ≈ 1.14 h), reveal angular momenta on the order of (10^{41}\ \mathrm{kg;m^2/s}). These values are hundreds of times greater than Jupiter's and incompatible with the idea of recent formation from a calm molecular cloud.

In *Stellar Metamorphosis*, such rotation is expected. Stars are not static "main sequence" entities but dynamically evolving systems that lose matter, shed energy, and contract over immense time spans. Red dwarfs gradually become brown dwarfs as their mass decreases and their radii collapse inward.

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2. Stellar Metamorphosis Framework

In SM, the life of a star is one continuous process of **mass dissipation, cooling, and contraction**. Young stellar bodies begin as large, hot plasma spheres. Over billions of years, they release matter through stellar winds, coronal ejections, and continuous plasma loss into surrounding space.

As their outer envelopes disperse, gravity compresses the remaining material, and the body's radius decreases substantially. Because angular momentum is approximately conserved:
[
\omega \propto R^{-2},
]

rotation accelerates dramatically as the object shrinks. This physical mechanism transforms a slow-rotating red dwarf into a compact, fast-spinning brown dwarf.

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3. Red Dwarf → Brown Dwarf Transition

Red dwarfs — small, dense stellar bodies — represent an intermediate stage of stellar contraction. As they age and lose their remaining plasma layers:

- Their total mass diminishes substantially.
- Their outer layers collapse inward.
- Their density increases while luminosity fades.
- Angular velocity increases as radius decreases.

In SM, a brown dwarf is therefore **not a failed formation**, but a **red dwarf that has aged and collapsed**, concentrating its rotational energy into a compact body. This process mirrors what happens later as brown dwarfs contract further into gas giants and eventually into rocky or metallic worlds.

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4. Example: 2MASS J12195156+3128497

This brown dwarf (≈55 MJ, ≈1 RJ, rotation ≈1.14 h) possesses an angular momentum near $(2\times10^{41}\ \mathrm{kg;m^2/s})$.
Such an object can be understood as the result of a **slow, long-term mass loss and contraction** process from a red dwarf ancestor possibly ten times larger in radius.

As the body's size decreased, its rotational speed increased proportionally to the square of the radius ratio. Even without external torques, the angular momentum conservation alone explains its present spin rate.

This implies that **the most rapidly rotating brown dwarfs are the most advanced in their metamorphic sequence** — older, denser, and further along the road toward planetary scales.

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5. Implications

1. **Age Relation:**
   Rotation rate correlates directly with stellar age — older objects spin faster because they have lost more mass and contracted more deeply.

2. **Planetary Continuity:**
   Brown dwarfs naturally evolve into gas giants and then into solid, Earth-like bodies as they continue cooling and shedding outer material.
3. **Observational Prediction:**
   A monotonic trend should exist between a star's decreasing mass and its increasing spin rate. Brown dwarfs at the threshold of becoming gas giants will exhibit the most extreme rotation periods (on the order of hours or less).
4. **Angular Momentum Conservation:**
   The high spin rates of brown dwarfs confirm that stellar contraction is ongoing and significant — direct evidence of metamorphic evolution rather than static classification.

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6. Conclusion

Rapidly rotating brown dwarfs such as **2MASS J12195156+3128497** provide key evidence that stellar evolution is a continuum of **mass loss and collapse**, not discrete formation categories. Their extreme spin is the natural result of gravitational contraction and angular momentum concentration over immense timescales.
Under *Stellar Metamorphosis*, these objects are simply **aging red dwarfs**, progressing step by step into the planetary realm.
