

The Initial Mass Function and Birth History of Brown Dwarfs in the Solar Neighborhood from a Volume-Limited Sample

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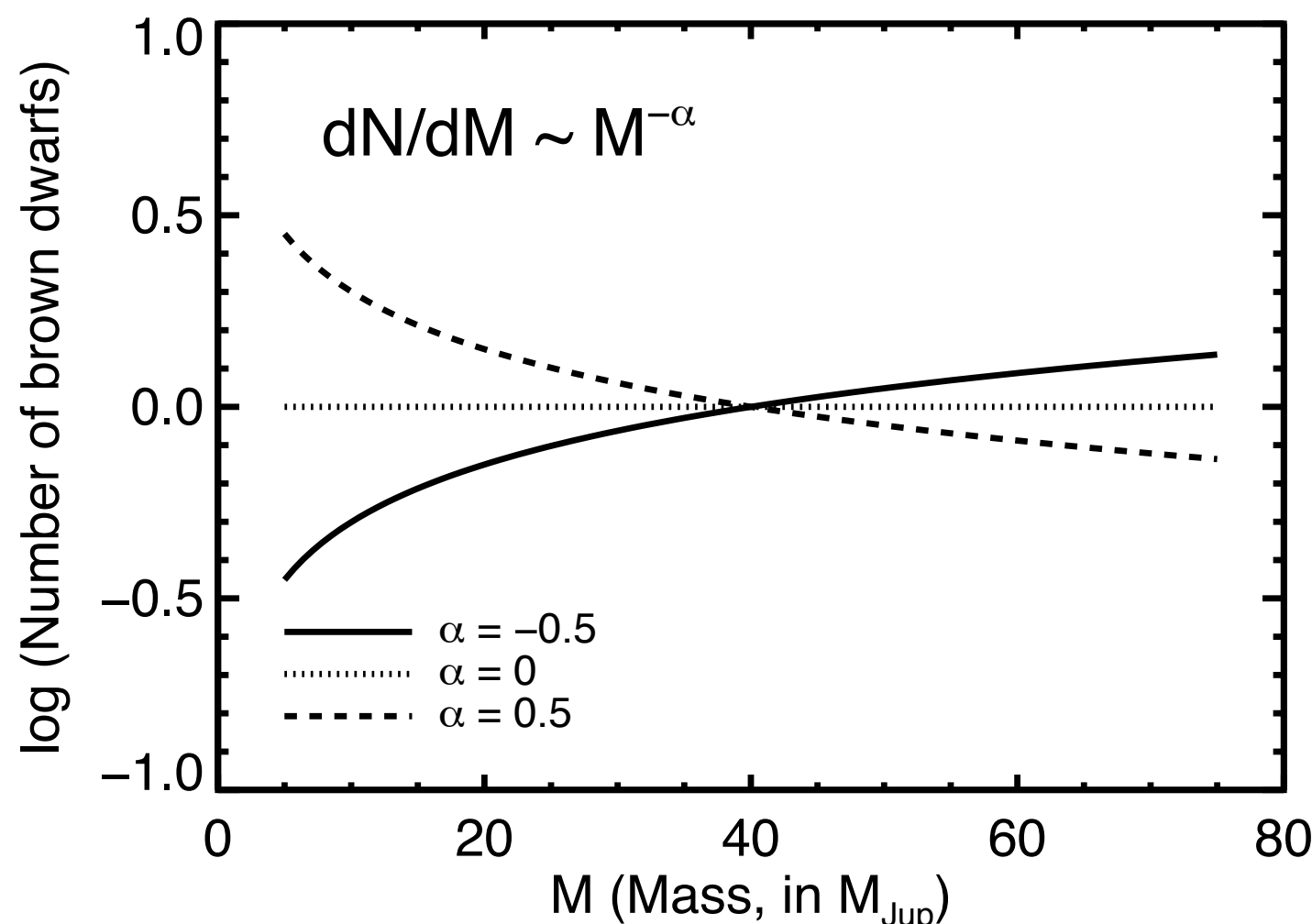
BACKGROUND

The substellar initial mass function (IMF) and birth history in the solar neighborhood are debated and not well constrained. We can **improve constraints with a complete volume-limited sample of brown dwarfs**.

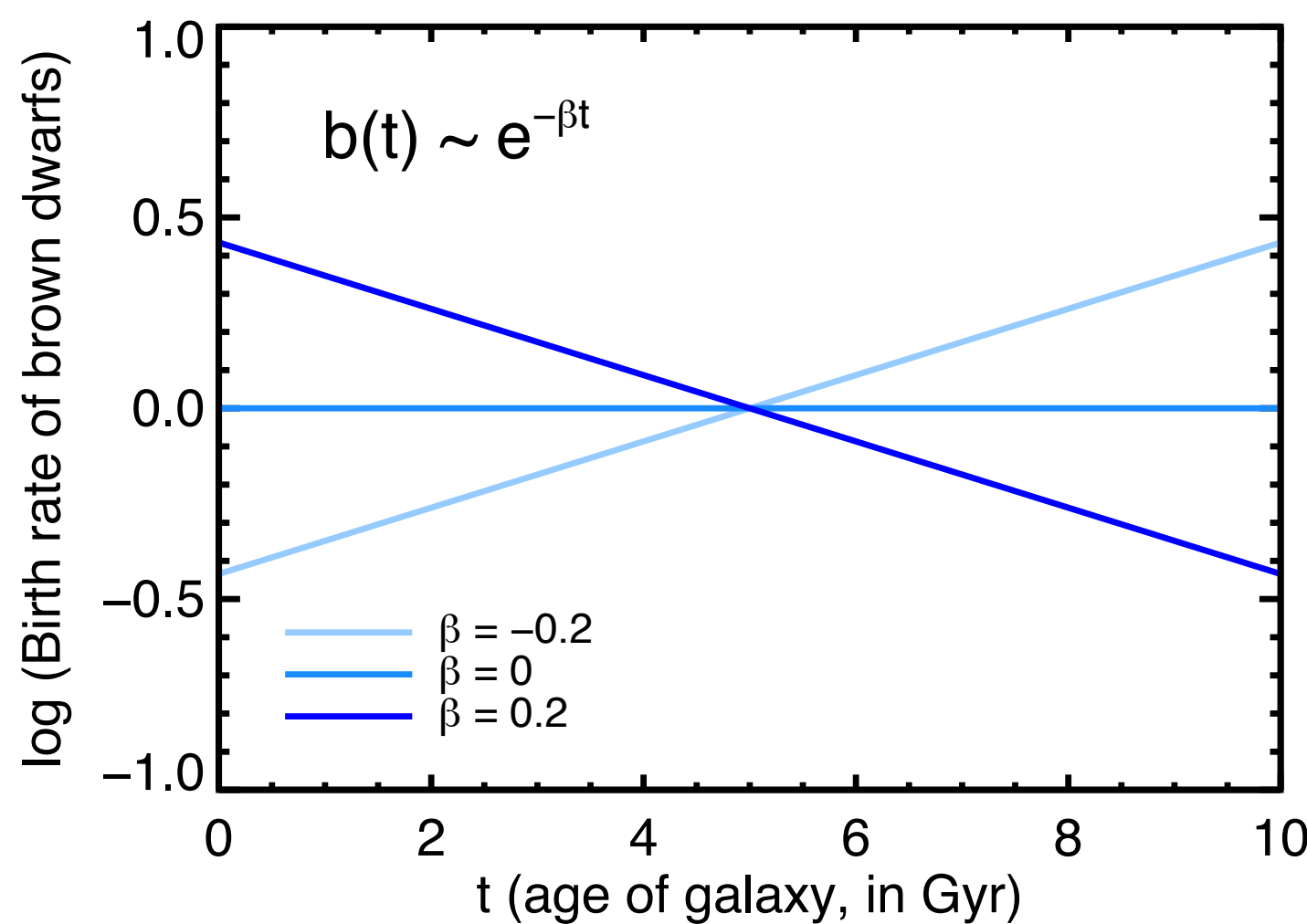
METHOD

- Created a **parallax-based volume-limited sample of L/T/Y dwarfs to 25 pc** from Best et al. (2021) and Kirkpatrick et al. (2021) samples.
- Created equivalent synthetic populations using the “hybrid” evolutionary models of Saumon & Marley (2008) and assumptions for IMF and birth rate (age distribution).
- Computed bolometric luminosity functions for all samples.
- Compared our volume-limited sample to synthetic samples using chi-squared.

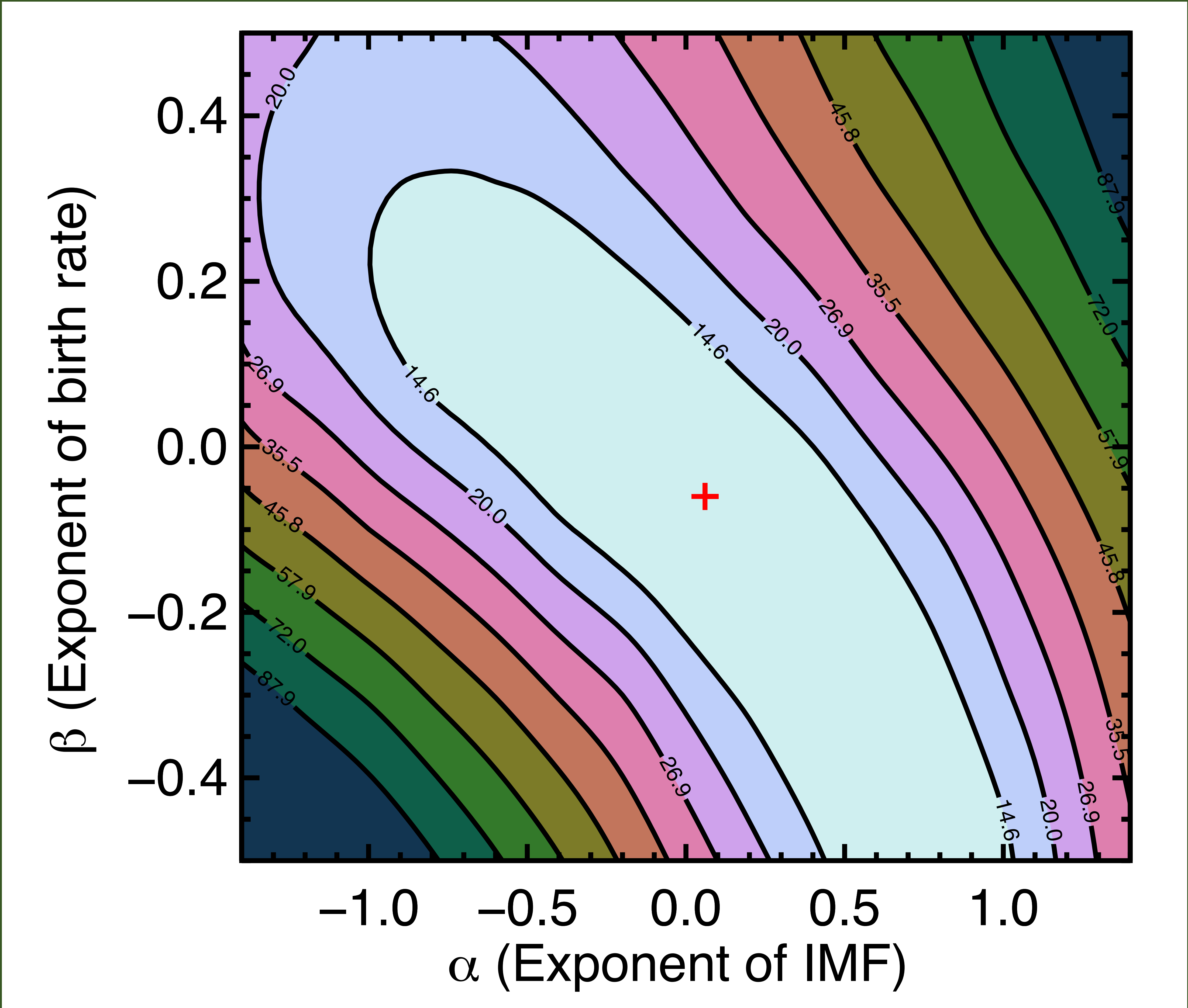
IMF (α parameter)



BIRTH RATE (β parameter)



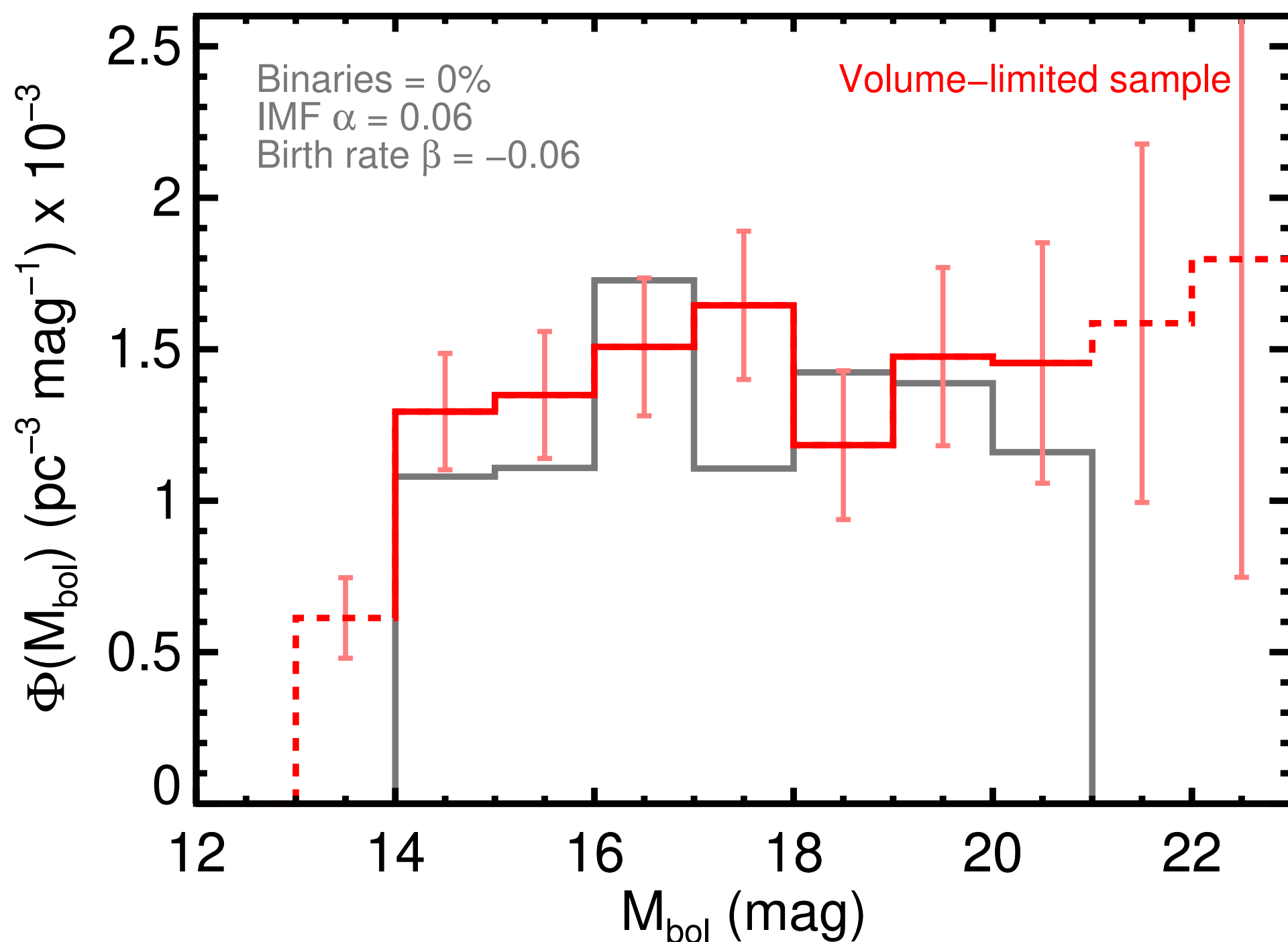
The local brown dwarf population is consistent with flat mass and age distributions.



IMF: Uniform/slight increase at lower masses $\alpha = +0.06 \pm 0.48$

Birth rate: Constant/slight decrease over time $\beta = -0.06 \pm 0.22$

RESULTS



Our best-fit synthetic luminosity function is shown above (gray), compared with our volume-limited sample (red). **We only used objects with $14 \leq M_{\text{bol}} < 21$ mag for our chi-squared comparison**, so our synthetic populations only span that range of bolometric magnitude.

The synthetic luminosity function features a concentration at $M_{\text{bol}} = 16\text{--}17$ mag due to slower cooling in transition from cloudy L to clear T dwarfs (Saumon & Marley 2008). Our sample has a comparable peak but at $M_{\text{bol}} = 17\text{--}18$ mag, **suggesting the L/T transition occurs at too warm T_{eff} in the models**.

COMPARISON WITH PREVIOUS WORK

Reference	Range	α
Kroupa 2001	10—80 M_{Jup}	0.3 ± 0.7
Allen+ 2005	40—100 M_{Jup}	0.3 ± 0.6
Pinfield+ 2008	T4—T8.5	$-1 < \alpha < -0.5$
Metchev+ 2008	T0—T8	≈ 0
Reyl�+ 2010	L5—T8	≤ 0
Kirkpatrick+ 2012	T6—Y1	$-0.5 < \alpha < 0$
Day-Jones+ 2013	L4—T4.5	$-1 < \alpha < -0$
Burningham+ 2013	T6—T8.5	$-1 < \alpha < -0.5$
Kirkpatrick+ 2021	L0—Y2	≈ 0.6
Our work	L0—Y2	0.06 ± 0.48

Our IMF is consistent with most previous work based on smaller samples. **Ours is the first study to statistically constrain the birth rate**.

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