The effects of gas accretion on planet formation

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Image Courtesy of Lynette Cook and Gemini Observatory/AURA
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Varying the rate of mass accretion by a proto-planet can drastically change its formation and the resultant planet population.

\[ f_{va04} = 1.668 \left( \frac{M_p}{M_{Jup}} \right)^{1/3} \exp \left( - \frac{M_p}{1.5M_{Jup}} \right) + 0.04 \]

\[ \dot{M}_{e,va04} = f_{va04} 3\pi \nu \Sigma_g \]

If the rate of gas accretion is too high, the formation of gas planets will be low.

\[ M_{c,\text{crit}} = 10M_\oplus \left( \frac{\dot{M}_c}{10^{-6}M_\oplus \text{ yr}^{-1}} \right)^{1/4} \left( \frac{\kappa}{1 \text{ g cm}^{-2}} \right)^{1/4} \]

\[ \tau_{KH} = 10^{\rho_{KH}} \text{ yr} \left( \frac{M_p}{M_\oplus} \right)^{q_{KH}} \left( \frac{\kappa}{1 \text{ g cm}^{-2}} \right) \]
Understanding the effects of physical properties on gas accretion

Viscosity ($M_{pl}$ vs. $a_{pl}$)

Temperature ($M_{pl}$ vs. $a$)

Viscosity ($M_{pl}$ vs. time)

Temperature ($M_{pl}$ vs time)
Understanding the effects of physical properties on gas accretion

Opacity
The effects of gas accretion on planet formation
Adjusting the opacity on a range from $\kappa = 0.5$ to $\kappa = 0.001$ gives a range of synthetic planet populations.
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Statistical Comparison:

<table>
<thead>
<tr>
<th>Opacity</th>
<th>P-value (a)</th>
<th>P-value (mass)</th>
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<tbody>
<tr>
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<tr>
<td>0.001</td>
<td>2E-189</td>
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</tr>
</tbody>
</table>

Best Model: $\kappa = 5E-3$
Conclusions:

- Gas accretion can significantly affect how a planet forms and migrates.
- Both visual and statistical comparisons of our models with the observed planet population show they do not come from the same distribution.
- For the next population synthesis, we need to vary more properties than opacity.
- *We learned a lot from this project and would like to thank the organizers for an excellent week!*
Increased Disk Life (~17.8 Myr)

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