Shocks and Similarities After Elastic Cord Reconnection

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Quantum Vortex Reconnections

Two vortices approach...

...exchange tails...

...and rapidly retract.
Quantum Vortex Reconnections

Two vortices approach...

...exchange tails...

...and rapidly retract.
The Experiment

- Paint Cord Every 5cm
- Secure Cord
- Pull Cord into Corner
- Record Corner Release
The Experiment
Our Equation of Motion

\[
\frac{\partial^2 \vec{r}}{\partial t^2} = v_E^2 \frac{\partial}{\partial s} \left[ \frac{\partial \vec{r}}{\partial s} - \frac{\partial \vec{r}}{\partial s} \left| \frac{\partial \vec{r}}{\partial s} \right| \right]
\]

\[v_E = \sqrt{\frac{EA}{\rho}}\]

- Characteristic velocity of the system
- Cross-sectional area of our cord
- Mass per unit length of our cord
- Young’s Modulus of our cord
Our Data

Raw Data
Frames 1-22 (500fps)
Our Data
Our Data

\[ x^* = \frac{x - x_0}{v(t - t_0)} \]

\[ z^* = \frac{z - z_0}{v(t - t_0)} \]
Our Data

Collapsed Data
Frames 5-22 (500fps)
The Implications

\[ \vec{g}(u) = \frac{x - x_0}{v_E(t - t_o)} \hat{i} + \frac{z - z_0}{v_E(t - t_o)} \hat{k} \]
The Implications

\[ \mathbf{g}(u) = \frac{\mathbf{r}(s, t)}{v_E t} \]

\[
\frac{\partial^2 \mathbf{r}}{\partial t^2} = v_E^2 \frac{\partial}{\partial s} \left[ \frac{\partial \mathbf{r}}{\partial s} - \frac{\partial \mathbf{r}}{\partial \mathbf{r}} \right] \quad \Rightarrow \quad u^2 \frac{\partial^2 \mathbf{g}}{\partial u^2} = \frac{\partial}{\partial u} \left[ \frac{\partial \mathbf{g}}{\partial u} - \frac{\partial \hat{g}}{\partial \hat{u}} \right] \]
The Implications

\[ u^2 \frac{\partial^2 \vec{g}}{\partial u^2} = \frac{\partial}{\partial u} \left[ \frac{\partial \vec{g}}{\partial u} \right] - \left| \frac{\partial \vec{g}}{\partial u} \right| \]
The Implications

\[ u^2 \frac{\partial^2 \vec{g}}{\partial u^2} = \frac{\partial}{\partial u} \left[ \frac{\partial \vec{g}}{\partial u} - \frac{\partial \vec{g}}{\partial u} \right] \]

\[ \frac{\partial^2 \vec{r}}{\partial t^2} = v_E^2 \frac{\partial}{\partial s} \left[ \frac{\partial \vec{r}}{\partial s} - \frac{\partial \vec{r}}{\partial s} \right] \]
Future Work

• Analytically solve our ODE
• Study the behavior of preliminary shock

Raw Data
Frames 1-22 (500fps)
Thank You

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