Data

Results

Summary

# Colors and spins of asteroids in LSST era





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#### Modeling

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New model validit

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# = Small bodies and planetary formation =

- Leftovers of the early Solar System
  - Remnants of planet building blocks
  - Limited dynamical & mineralogical evolution

- Orbital and size distributions
- Distribution of composition

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Solar System Science		

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New model validity

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#### — What do we need to study?



- Discovery & Dynamics
  - Dynamical structure
  - Origins & evolution
  - Astrometry

#### • Composition

- $\circ~$  Location & timing of formation
- Compositional structure
- Vis-NIR spectro-photometry
- Physical properties
  - Diameter, Spin, ...
  - Main evolutionary drivers
  - ▷ Time serie photometry

What LSST will bring to Solar System?	What LSST will bring to Solar System?	What LSST will bring to Solar System? Image: Control of Antrol / Antrol									
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# — What LSST will bring to Solar System?

	Currently Known	LSST Discoveries	Typical number of observations
Near Earth Objects (NEOs)	~20,000	200,000	(D>250m) 60
Main Belt Asteroids (MBAs)	~650,000	6,000,000	(D>500m) 200
Jupiter Trojans	~7000	280,000	(D>2km) 300
TransNeptunian Objects (TNOs) + Scattered Disk Objects (SDOs)	~3000	40,000	(D>200km) 450
Comets	~3000	10,000	?
Interstellar Objects (ISOs)	2	10	?

LSST

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Solar System Science

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Summai

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LSST

LSST SSSC



LSST

#### $\Rightarrow$ Discovery, astrometry, colors, time series

	LSST			
The ch	allenge of	SSO variability		 _



		Modeling SSO Photometry			
Model	ing the p	hotometry of SSC	)s ====	 	_

• Distance



		Modeling SSO Photometry			
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• Distance



		Modeling SSO Photometry			
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• Distance



○ HG Bowell1989

#### $H=m - f(r, \Delta)$

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 $H=m-f(r,\Delta)$ 

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• Distance		• Phase			
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$\circ$ HG Bowell1989					

 $H=m-f(r,\Delta)$ 

	Modeling SSO Photometry		
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O HG Bowell1989	• HG Bowell1989		
	$\circ$ $HG_1G_2$ Muinonen-	+2010	
$H=m - f(r, \Delta)$	$H=m - f(r, \Delta)$ -	$-g(\gamma)$	

Summ

# — Modeling the photometry of SSOs

• Distance





• Phase





 $\circ$  HG Bowell1989

 $\circ \ HG_1G_2 \ \text{Muinonen+2010}$ 

 $H=m - f(r, \Delta) - g(\gamma)$ 

• Aspect!



Mahlke+2021

 $H=m-f(r,\Delta)$ 



		Modeling SSO Photometry			
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		$\circ~\text{HG}_1\text{G}_2$ Muinonen-	+2010		

 $H=m - f(r, \Delta) - g(\gamma)$ 

 $H=m - f(r, \Delta)$ 



		Data		
— Data —	 			





			Data		
— Data:	FINK!	Julienpeloton =			_



#### = Validation: Fit



# Solar System Science LSST Modeling SSO Photometry Data New model validity Results Summary ---- Validation of phase: $g(\gamma)$



= Validation of spins:  $s(\alpha, \delta)$ 



## $\longrightarrow$ Validation of colors: sHG<sub>1</sub>G<sub>2</sub>



Sum

Results

#### = Spin orientation



			Results	
—— Spin or	ientation			



Solar System Science LSST Modeling SSO Photometry Data New model validity Results Summary

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#### • Questions on Solar System & Planetary formation require

- Discoveries for large statistics on SSOs
- o Including multi-filter and time-serie photometry
- LSST of Vera C. Rubin is highly promising

#### • Challenges linked with SSO photometry

- Combination of short- and long-term variability
- ▶ New model put forward here:  $sHG_1G_2$

#### • sHG1G2 implemented in FINK over 2023

- $\circ~$  Run monthly  $\rightarrow$  Dec.2023  $\rightarrow$  115,000 SSOs
- $\circ~sHG_1G_2$  works and improves over previous models
- Phase & spin parameters & g-r color for  $\approx$ 50,000 SSOs
- Ready for LSST!