1) **Tests of standard model of cosmology and beyond**

- Time-delay cosmography: $H_0$ + Dark Energy
- Galaxy mass distribution and small scale substructures: tests of CDM, incl. density of compact objects

2) **Observations through Gravitational telescopes**

- Spectroscopic scrutiny of high-z SNIa “standard candles”
- Window to the highest redshift SNe, a window to the first generation of core-collapse and pair-instability SNe
Why Roman?

- Survey area
- Cadence
- Depth
- NIR sensitivity
- Spatial resolution

Goobar et al 02 (SNAP satellite forecast!)
Why Roman?

+ synergies/complementarity with shallower/wider LSST survey

- Survey area
- Cadence
- Depth
- NIR sensitivity
- Spatial resolution

Goobar et al 02 (SNAP satellite forecast!)
Key points:

- Precise time delay between SN images
- Precise SN image positions
- Deep images of host galaxy for lens modeling
- Deep images of lens + surroundings to infer structures in the line-of-sight

HST images of iPTF16geu
Dhawan et al 2020

2016 - 2018 = Difference
Key points: *time-delay cosmography*

- Precise time delay between SN images
- Precise SN image positions
- Deep images of host galaxy for lens modeling
- Deep images of lens + surroundings to infer structures in the line-of-sight
- Accurate redshifts and stellar velocity dispersion in lensing galaxy can be obtained from supporting observations

HST images of iPTF16geu
Dhawan et al 2020

2016
2018
Difference
Key points:

**Galaxy mass profile**

- Galaxy central profiles (core/cusp) is an important diagnostic for the nature of DM

- Lens model limiting factor in QSO time-delay cosmography

Mörtsell et al 2020
Key points:

**small-scale substructures (I)**

- Precise magnification measurements possible for SNIa, can be used to test lens model assumptions
Key points: **small-scale substructures (II)**

- Precise magnification measurements for SNIa, can be used to test lens model assumptions

- Anomalous flux ratios between images indicate *secondary - lower mass- lenses* (micro or millilensing)

Goobar et al 2017
**Key points:**

**extinction corrections**

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**Figure 6.** (Left) The observed colour excess for the resolved images in each filter relative to $F814W$ plus the model absorption in the $F814W$ filter compared to the best fit model absorption in each filter assuming the CCM89 dust law. The absorption from the host galaxy dust is plotted in black. For Image 1 we can see that the host galaxy is the dominant source of extinction, and for images 2,3,4 there is a progressively larger contribution from the dust in the lens galaxy. (Right) magnification distribution for the individual images for the fiducial case of host and lens $R_V$ fixed to 2 compared to the predictions from the model assuming the lens to be a single isothermal ellipsoid (dashed-dotted lines; see Mörtsell et al in prep for details. The model prediction for $\mu$ of Image 2 has been shifted down by 0.5 so that it can be distinguished from the value for Image 3).
Key points: GT’s verifying accuracy of SNIa as distance indicators

Unlensed at $z=1.5$ (6 hs HST)

Rodney et al 2012
Key points: GT’s verifying accuracy of SNIa as distance indicators

Unlensed at $z=1.5$ (6 hs HST)

Petrushevska+17

Rodney et al 2012

Shown to have similar matches in the low-z universe. "Standard candle" nature OK – at least in this case!
Key points: GT’s
First generation of supernovae may be detected with lensing magnification

With lensing $z \sim 15$ within reach!

Courtesy of Dan Whalen
Cadenced observations with Roman are arguably the best strategy to find and study lensed SNe.

The science is rich, involves many hot topics in cosmology and astrophysics.

ESA led effort in this direction?
Summary

- Cadenced observations with Roman are arguably the best strategy to find and study lensed SNe.
- The science is rich, involves many hot topics in cosmology and astrophysics
- ESA led effort in this direction?

Thank You

Nancy Grace Roman Space Telescope
1) **Tests of standard model of cosmology and beyond**

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- Small scale substructures: tests of CDM + compact objects

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First generation of supernovae may be detected with lensing magnification.

![Graph showing the probability of lensing magnification ($P_{sl}(z_s)$) and its variations with different lensing measures ($\mu_{tot} > 10$ and $\mu_{bri} > 10$).](image)

$z = 7$ to $z = 14$

With lensing, $z \sim 15$ within reach!

Oguri 2019
## Roman specs

### Roman Space Telescope Imaging Capabilities

<table>
<thead>
<tr>
<th>Telescope Aperture (2.4 meter)</th>
<th>Field of View (45’x23’; 0.28 sq deg)</th>
<th>Pixel Scale (0.11 arcsec)</th>
<th>Wavelength Range (0.5-2.3 μm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Filters</strong></td>
<td>F062</td>
<td>F087</td>
<td>F106</td>
</tr>
<tr>
<td>Wavelength (μm)</td>
<td>0.48-0.76</td>
<td>0.76-0.98</td>
<td>0.93-1.19</td>
</tr>
<tr>
<td>Sensitivity (5σ AB mag in 1 hr)</td>
<td>28.5</td>
<td>28.2</td>
<td>28.1</td>
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</tbody>
</table>

### Roman Space Telescope Spectroscopic Capabilities

<table>
<thead>
<tr>
<th>Grism</th>
<th>Field of View (sq deg)</th>
<th>Wavelength (μm)</th>
<th>Resolution</th>
<th>Sensitivity (AB mag) (10σ per pixel in 1hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.28 sq deg</td>
<td>1.00-1.93</td>
<td>461</td>
<td>20.5 at 1.5 μm</td>
<td></td>
</tr>
<tr>
<td>Prism</td>
<td>0.28 sq deg</td>
<td>0.75-1.80</td>
<td>80-180</td>
<td>23.5 at 1.5 μm</td>
</tr>
</tbody>
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