Extinction Study toward the Inner Milky Way with Subaru HSC

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Cardelli’s extinction law

➢ #of citation : 7860 (as of yesterday)
➢ But, the inner Milky Way behaves different from Cardelli’s law  
  (Sumi04, Nishiyama+06,08, Nataf+13)
Microlensing relies on the extinction law

✓ Light curve is observed in optical
✓ Extinction using Red Clump in CMD
✓ Use extinction law to estimate the NIR extinction for the NIR AO follow-up (to characterize source and lens)

✓ VVV extinction map could be used, but differential reddening is significant and VVV extinction map itself depends on the assumed extinction law
NIR μlensing relies on the extinction law too

- Microlensing observation is shifting to NIR
  - ✔ PRIME (PRime-focus Infrared Microlensing Experiment)
  - ✔ WFIRST

- Can the NIR microlensing event be detectable in optical?
  → Need extinction law toward highly obscured region

Udalski+15
Disagreement

➢ Nishiyama papers found that NIR extinction is $\propto \lambda^{-2}$, whereas Cardelli’s $\lambda^{-1.6}$

➢ Observed $A_V/A_K$ is 60-80% higher than Cardelli’s law with $R_V=3.1$ (Nishiyama+08, Nataf+16)

Deep optical images toward highly obscured region are needed
HSC obs toward the inner Milky Way

✓ Subaru HSC; $g,r_2,i_2,z$
✓ Galactic bulge including WFIRST microlensing survey field
  18 HSC footprints
✓ shallow / deep imaging
✓ Queue mode and classical mode observations over several nights in S17A
CMD

Deeper than Pan-STARRS DR2

Used VVV DR4 data
Cardelli’s law doesn’t agree with the HSC data and NIR extinction law ($\propto \lambda^{-2}$) → estimating the optical (NIR) extinction from the NIR (optical) values w/ the Cardelli’s law would fail to inner Milky Way

Measured points could be fit with Cardelli’s law (ignoring NIR)

Note: I combined and used all the available HSC data.
More detail analysis will be needed.
Discussion

- Galactic longitude dependence?
- Analysis including northern bulge ($b > 0$)
- Need to check consistency between HSC data and Nishiyama’s single power law model ($\propto \lambda^{-2}$)
- Any application to other highly obscured region?
Summary

✓ Most often used Cardelli’s extinction law could be wrong for the inner Milky Way.

✓ Used Subaru-HSC deep/shallow imaging with g,r2,i2,z toward the bulge (including WFIRST microlensing field) to measure Red Clump.

✓ Cardelli’s law with any $R_V$ value does not explain observed extinction from NIR to optical.