Future Surveys Need Future Analysis

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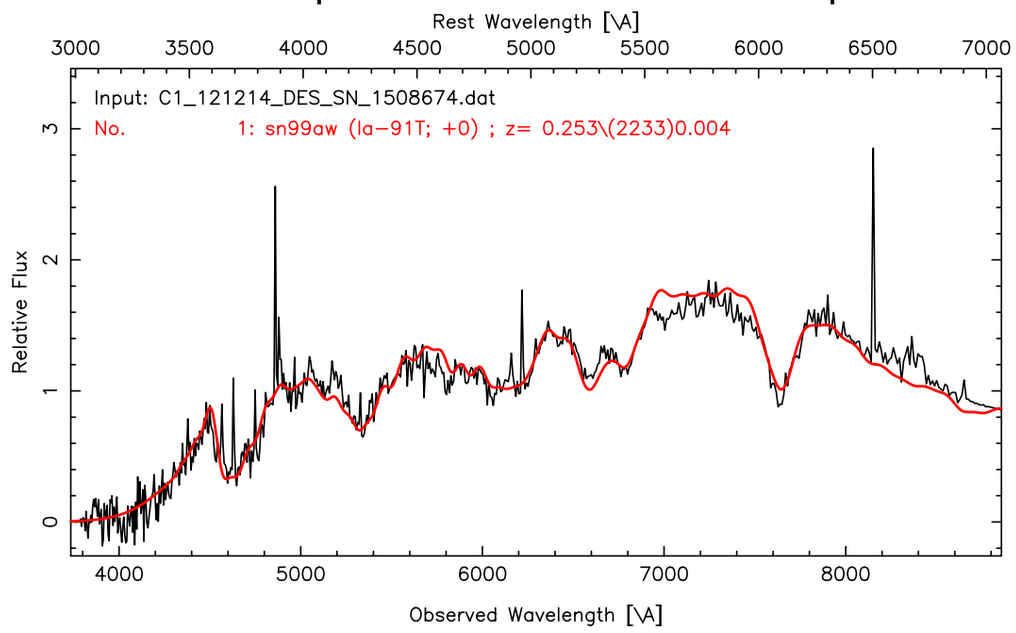
Incomplete Spectroscopy

- Spectroscopy gives
  - Transients typed as SNIa
  - Host galaxies identification
  - Highly precise redshift
- No Spectroscopy gives
  - Uncertain type
  - Uncertain host galaxy
  - Imprecise redshifts

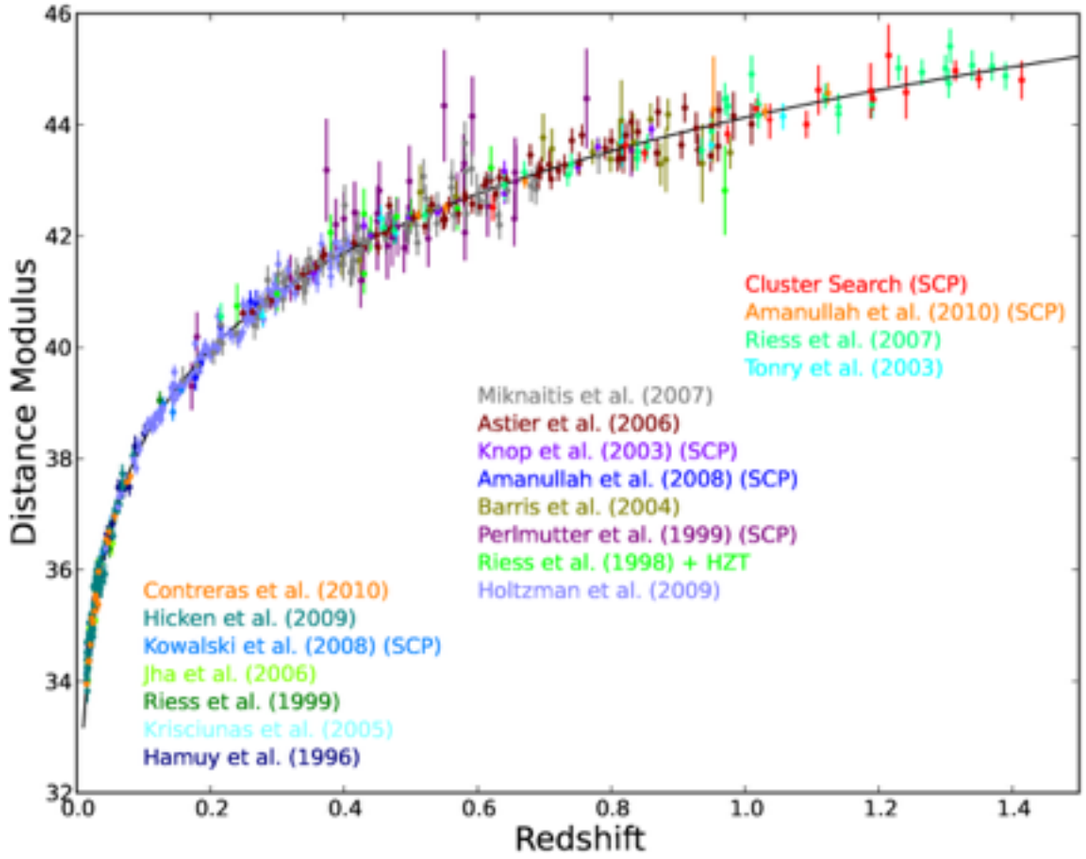
OzDES spectrum of DES Supernova



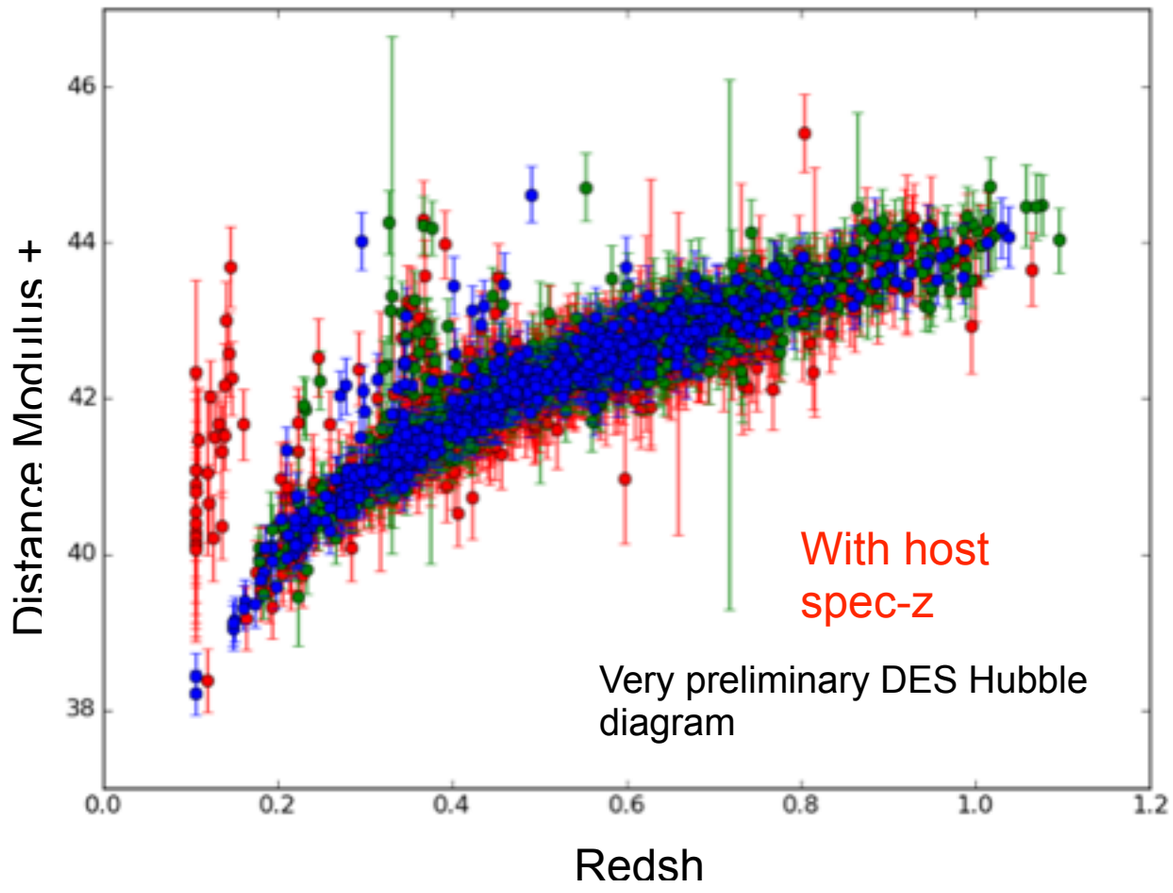
SN Ia

Many Ground-Based Programs Require a Different Kind of Hubble Diagram Analysis

Pre-DES, LSST



DES, LSST

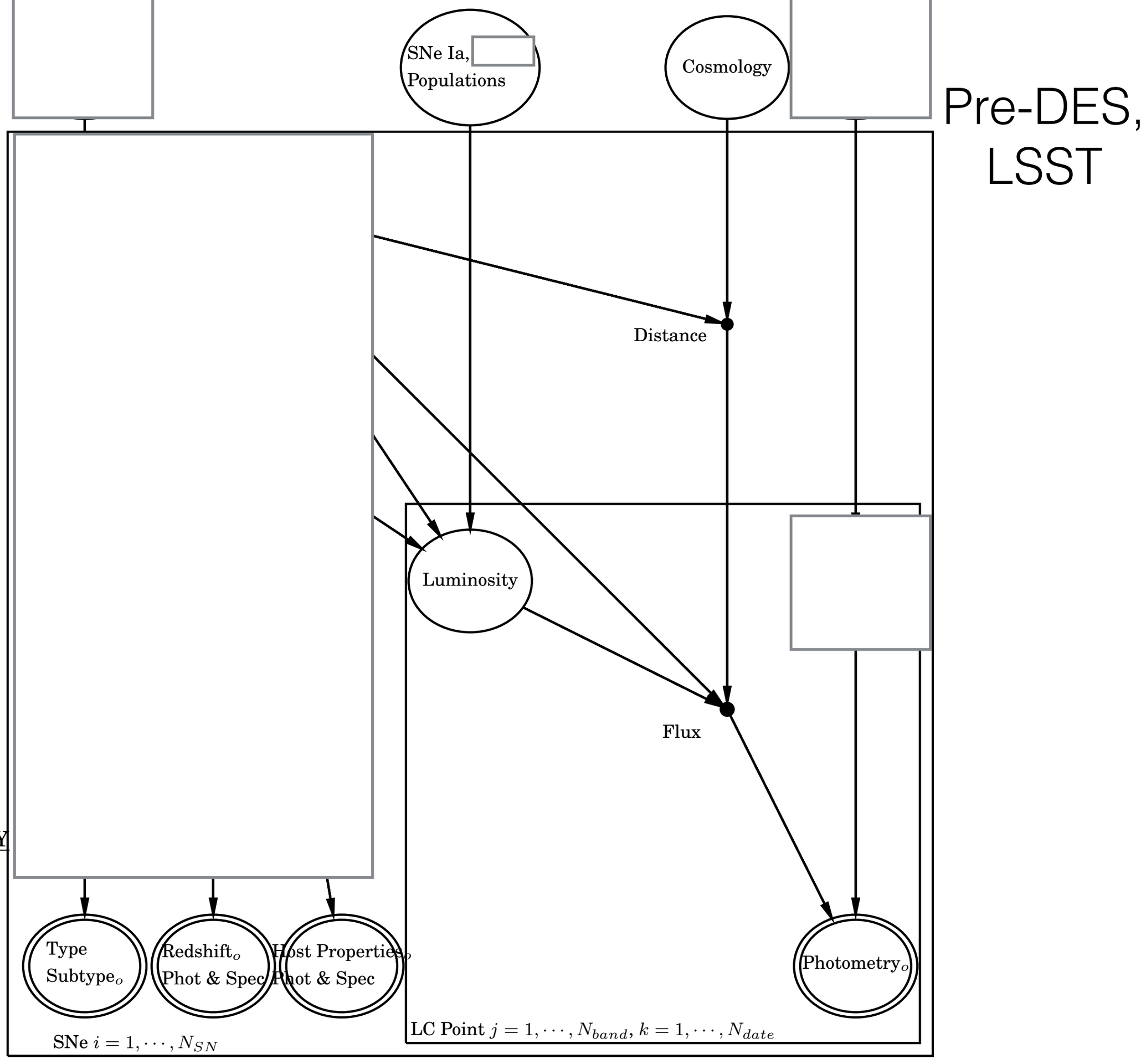


UNIVERSAL

INDIVIDUAL SN

OBSERVATORY

DATA

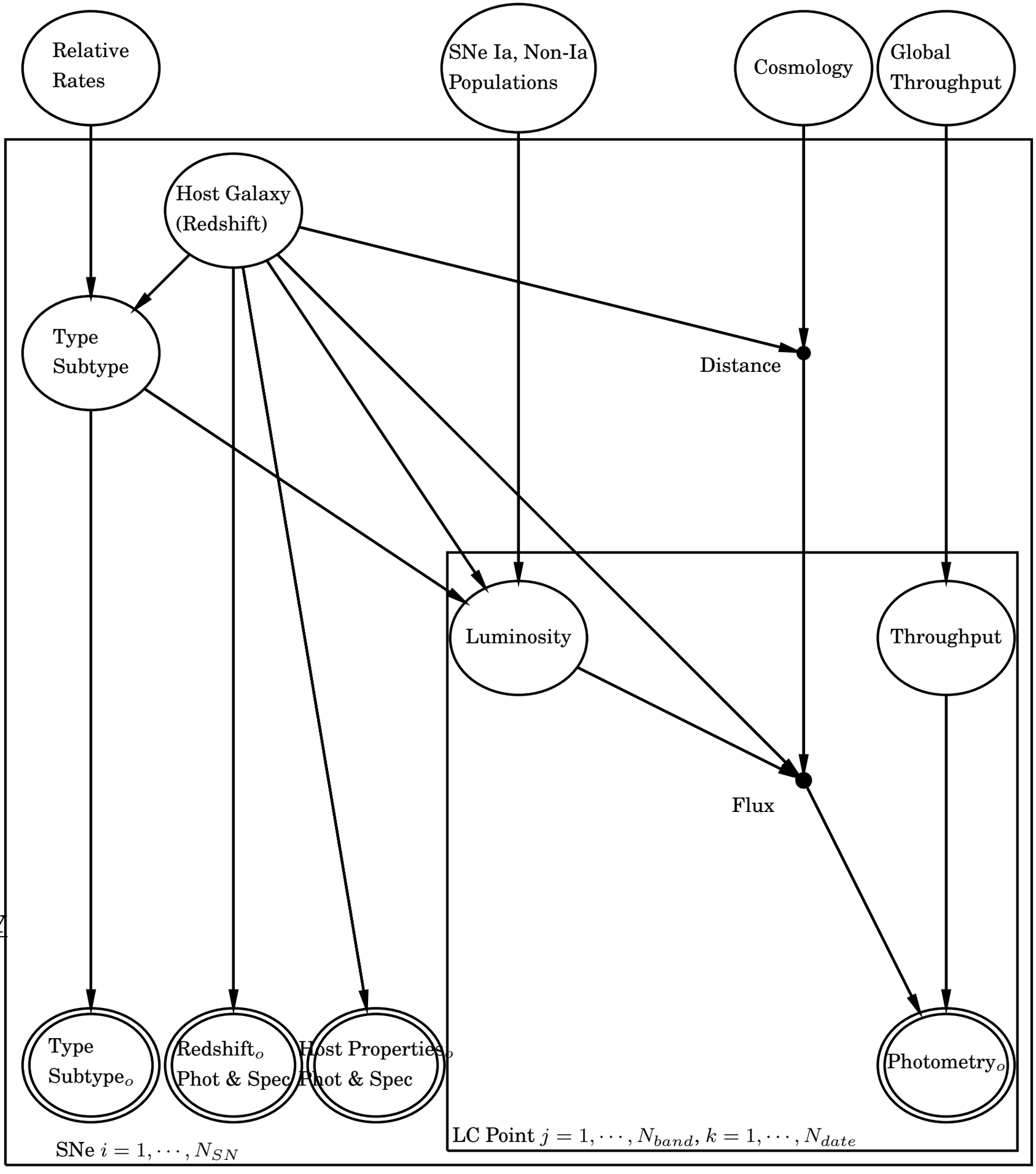


UNIVERSAL

INDIVIDUAL SN

OBSERVATORY

DATA



DES, LSST

UNIVERSAL

INDIVIDUAL SN

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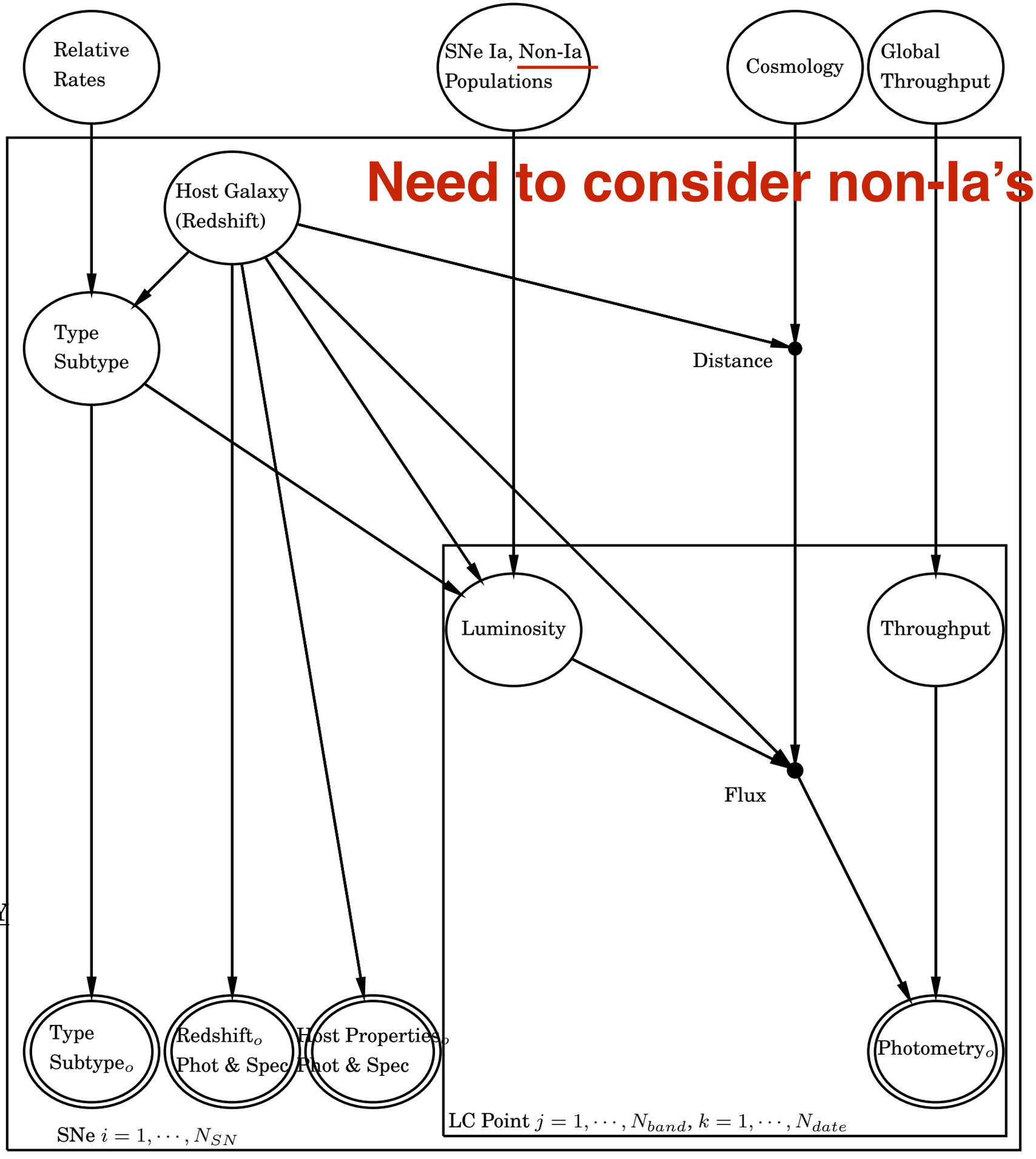
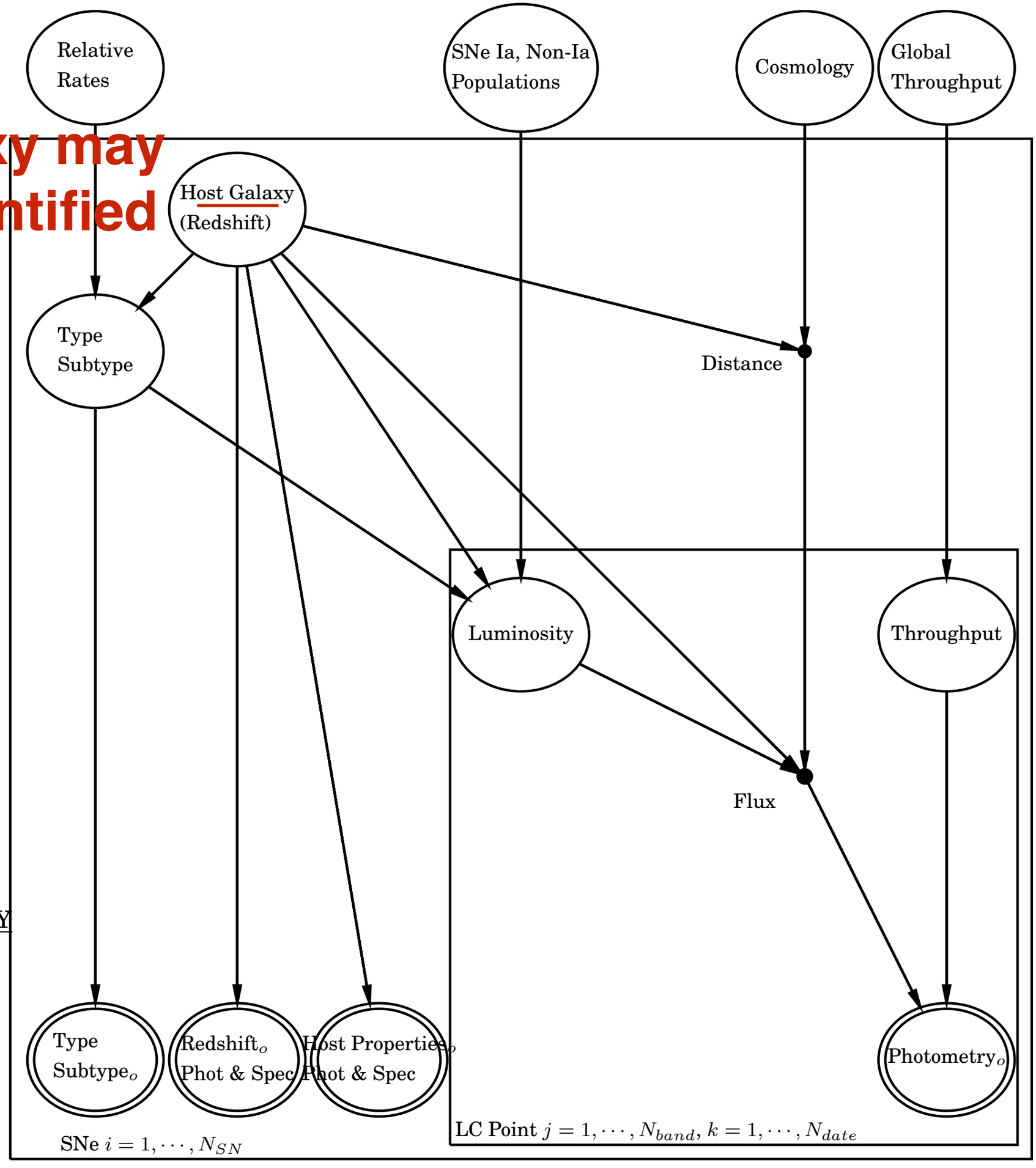
DATA



DES, LSST

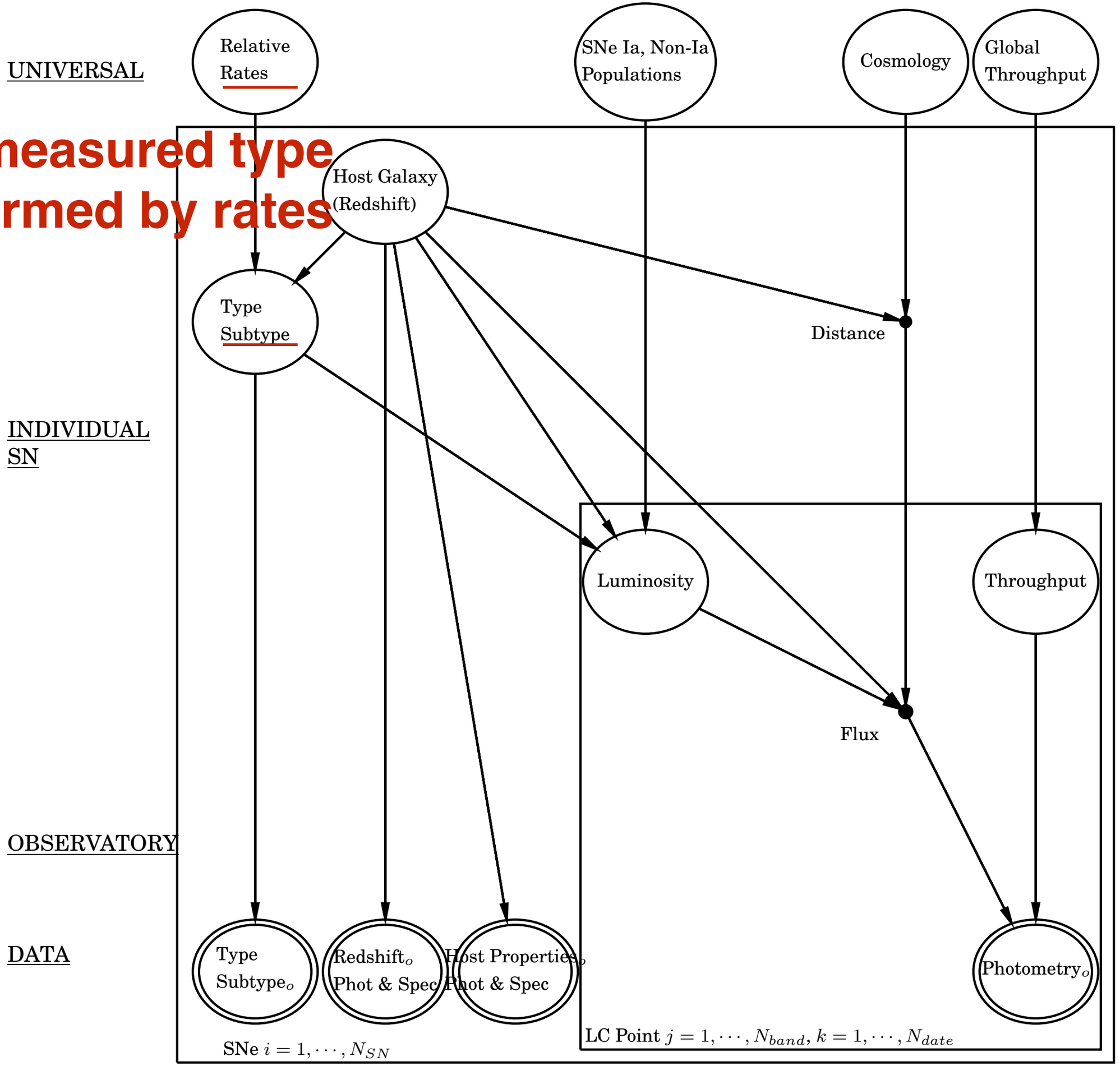
Host galaxy may be misidentified

DES, LSST



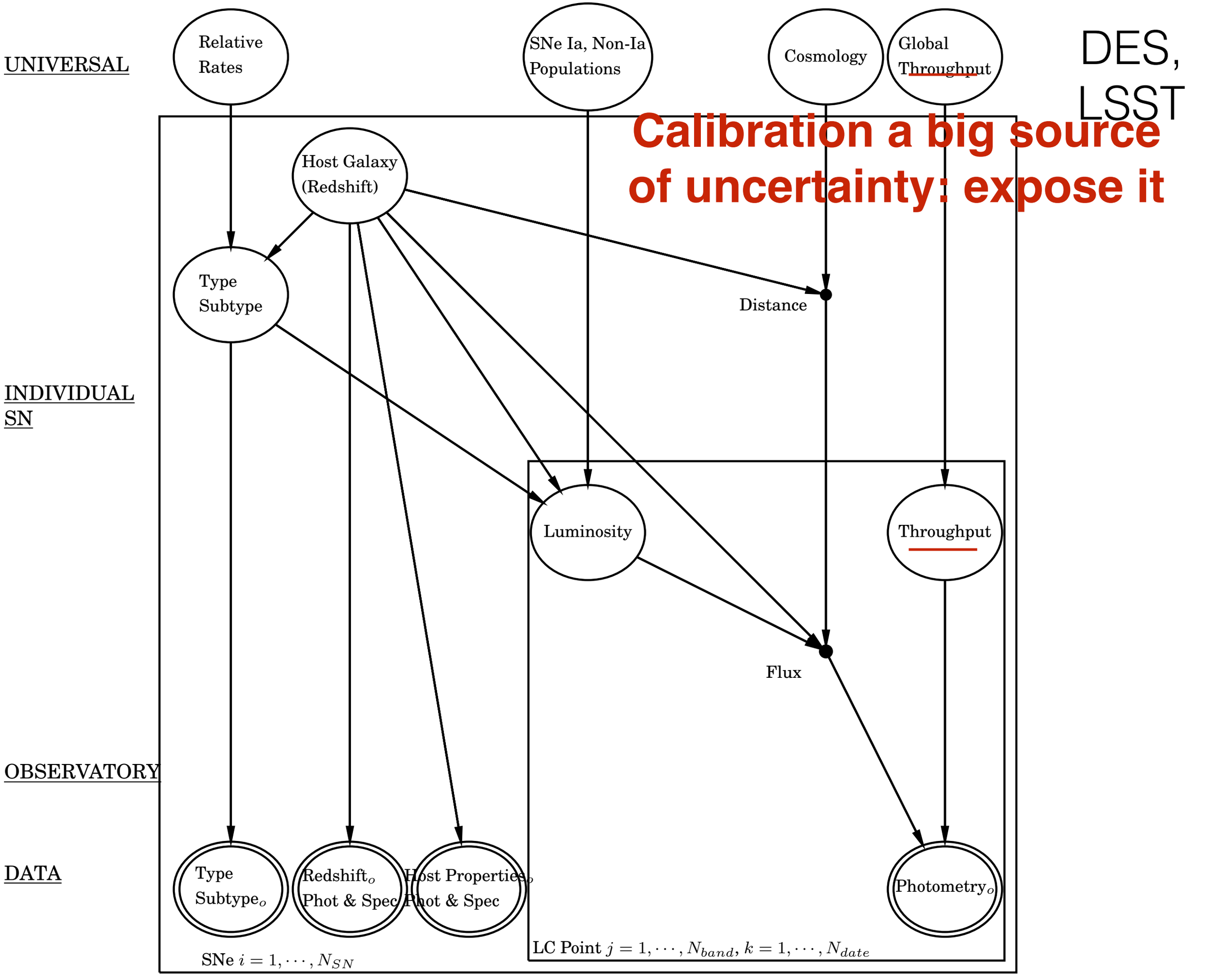
Unmeasured type informed by rates

DES, LSST



DES, LSST

Calibration a big source of uncertainty: expose it



Likelihood

- For one supernova the likelihood is

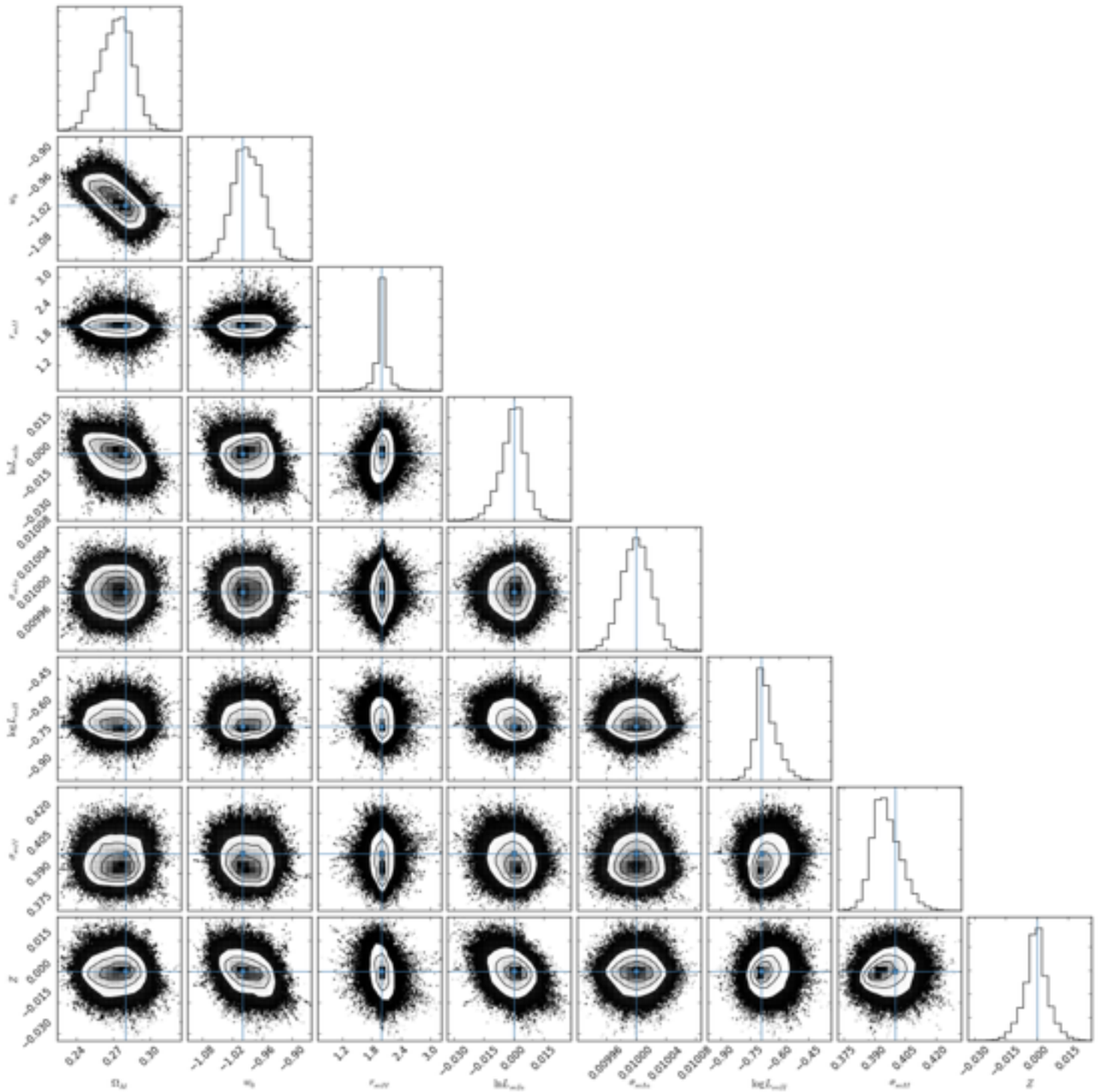
$$\mathcal{L}(T_o, z_o, c_o | S_c, S_T, z, X)$$

  - Read as “probability of measured type, redshift, and counts *given* that supernova is in our sample, has a successful type, and has underlying parameters”

- Sample selection matters in the likelihood

Determining the PDF is a Statistical Challenge

- Able to construct parameter PDF's for ~100 SNe using Affine Invariant MCMC (emcee) but…



Determining the PDF is a Statistical Challenge

- LSST produces >10^4 SNe!
  - Each SN is associated with several parameters
- Curse of dimensionality for Metropolis-Hastings MCMC algorithms
- Hamiltonian Monte Carlo is the only algorithm (I know of) that successfully handles such huge parameter sets …
  - … but due to an integral in the likelihood I have not got one to work
- A problem for other cosmological probes
- Group mobilizing to solve this problem: Sam Hinton (U. Queensland)