Stellar Populations:
Diagnostics of Galaxy Structure & Evolution

1. **Resolved stars**
   - Individual stellar chemical abundances—detailed abundances with high resolution spectra (R≥25000), including isotopes; mean abundances from low resolution (R~2000-5000) spectra [e.g. "calcium triplet, CaT method for red giant stars].
   - Individual stellar velocities; binary stars; streams and other kinematic structures (e.g tidal debris trails); velocity dispersions vs. stellar ages—e.g. dwarf spheroidal galaxies.
   - Stellar ages—locating main sequence turnoffs (MSTOs) in field populations; presence of special classes of stars (e.g. RR Lyr, Cepheids, AGB); best from star cluster CMDs fit with isochrones. Age-metallicity relationships (AMRs) and dispersions.
   - Stellar mass functions and estimates of IMF
   - Star formation histories—numbers of stars born per unit time from fits to densities of stars on color-magnitude diagrams (CMDs) [= "Hess diagram"] and in color-color space + population synthesis models.
   - Interstellar extinction studies from color differentials and absorption lines and bands.
   - Spectra: RGB: high resolution generally Milky Way & satellites, low resolution Local Group; supergiants to ~10 Mpc.
2. **Resolved star clusters**
   - Chemical abundances of major elements from integrated spectra, e.g. Fe group, sample r- & s-process elements. Low internal dispersions→ sharp lines, reasonable data.
   - Ages from colors + abundances or fits to spectra; cluster formation and destruction rates, AMRs.
   - Radial velocities; e.g. halo kinematics from globular clusters.
   - Masses if radii and velocity dispersions measured; M/L tests of IMFs.
   - Spectra: high resolution-Local Group; low resolution Local Supercluster.
3. **Unresolved galaxies**
   - Spectra of stellar population components luminosity weighted at each wavelength.
   - Mean stellar population ages & basic age mix from multiwavelength coverage.
   - Basic chemical abundances—overall levels; α-element enhancements.
   - Overall star formation rates (SFRs); relative measures better than absolute.
   - Mean radial velocities and velocity dispersions integrated through galaxy—masses and kinematic structures.
   - Mean interstellar obscuration levels.
   - Low resolution spectra feasible to high redshifts; integrated light photometry to z>6.