

Future Challenges

Today's burning questions in EGPN research, and the strategies, tools & techniques needed to answer them

Outline:

1. Overview (10 min)
2. Open Discussion

What is the Path Forward?



- What are the major scientific questions in EGPN research?
- What are the most viable strategies for addressing them?
- What facilities will be necessary to execute these strategies? What facilities are on the horizon that can be applied to EGPN research?
- What kinds of collaborations will be necessary?
- What else can we do as a community to enable progress in this field?

Pressing Research Questions

(an incomplete list...)

- The formation mechanism(s) of PNs
 - The solution of the progenitor/core mass relation
 - The origin of nebular morphology
- The co-evolution of PNs and their central stars
 - The role of dust in formation & evolution
- The origin of the PNLF
- The effects of host galaxy chemistry & SFH have on the PN population
- The chemical evolution of host galaxies
- The internal dynamics of host galaxies; effect of dark matter
- The nature and extent of the intra-cluster stellar population
- Others?

Strategies

- ✓ PN Census of Local Group galaxies, complete to ~ 5 mag below the L(5007) peak
- ✓ Census of intra-cluster PNs to ??? Depth
 - ✓ Include RV survey
- ✓ Census of Mira and Carbon stars in Local Group
- ✓ Census of PN morphology in a variety of host galaxy environments
 - ✓ Includes census of CS properties
- ✓ Modelling of PN + CS systems in MC & other selected LG galaxies
- ✓ Deep spectroscopic surveys of large EGPN samples
- ✓ IR census of MCPNs
- ✓ Other approaches?

Facilities

➤ Current Technology

- Wide-field FPA imagers on 4-m class telescopes (NOAO Mosaic, CFHT Omegacam, etc.)
- PN Spectrograph
- HST: ACS, STIS
- Spitzer: IRAC, ???
- Multi-fiber, IFU spectrographs on 8-m class telescopes

➤ Next-generation Technology

- Multi-Conjugate Adaptive Optics (MCAO) on 8-m class telescopes (e.g., Gemini GSAOI: 0.02 arcsec/pix over 1 arcmin FOV)
- JWST: near- to mid-IR, high-res, low BG imaging & spectroscopy
- LSST, Pan-STARRS all-sky, time-domain surveys to ~24th mag, astrometric surveys
- ALMA, SKA

➤ Future-generation Technology

- 20m, 30m, or 100m optical/IR telescopes

Putting it All Together

Project	Qs Addressed	Required Facilities
LG PN Census	PNLF, Host galaxy effects	Wide-field imagers
IC PN Census	Galaxy dynamics, IC stellar pops	Wide-field imagers, PN.S
LGPN Hi-res Imaging	PN origins, populations, morphology, host galaxy influences	HST, JWST, MCAO on 10m or 30m telescopes
AGB, M, C-star census	PN formation, I/F core mass, AGB mass loss	Wide-field imagers, LSST
LGPN Spectroscopic Survey	Populations, host galaxy effects,	Multi-fiber or IFU spect., 8-10m telescopes
LGPN IR Survey	Role of dust in PN formation, evolution, PNLF	JWST, ??

Collaborations & Resources

- Is it time to consider one or more large collaborative efforts to press forward with these research questions?
- Advantages:
 - Coherent plan for attacking multiple, major research questions
 - “Interdisciplinary” approach:
 - More compelling science case
 - stars, galaxy researchers working happily together
 - Coordinated (more successful?) requests for observing time
 - Coordinated plan for obtaining, reducing, analyzing, publishing data
- Disadvantages
 - Requires dedicated, selfless scientific/project leadership
 - Overhead of management & coordination
 - Egos, publication strategy

Other Issues

- What else might we be doing as a community?
 - Creation of research resources for benefit of the field
 - Catalogs
 - VO resources
 - Nomenclature standard
 - Other??