Search for binary central stars of planetary nebulae: exploiting archival data

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Outline

- Planetary Nebulae: how, when and why?
  - Morphology of PNe: the role of binary central stars
- A new an updated catalogue of galactic CSPNe
- Searching for binary central stars in archival data
  - Variability in photometric surveys
  - Infrared excess
- Summary
Formation of PNe

Life Cycle of a Low-Mass Star

Protostar
Main Sequence Star
Red Giant
Helium Burning Star
Double-shell Burning Red Giant
Planetary Nebula
White Dwarf

M ~ 0.8 - 8 M☉
Formation of PNe

Life Cycle of a Low-Mass Star

M ~ 0.8 - 8 M☉
Formation of PNe

What theory says:

Slow wind
Fast wind

What we (sometimes) observe:

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BUT WE ALSO OBSERVE…
Formation of PNe

80% of PNe are asymmetrical
Formation of PNe

Binarity

Magnetic fields
Formation of PNe

Binarity

Magnetic fields
Credits: Thomas Goertel, Space Telescope Science Institute
Binarity in PNe

Jones (2015)
Binarity in PNe

Known close binary CSPNe ~50

Around 3000 PNe in our galaxy!!!

Jones (2015)
A new Galactic PNe Catalogue

Previous catalogues of PNe:
- First (known) catalogue of Galactic PNe: 1063
- Strasbourg-ESO Catalogue of Galactic PNe: 1143
- Version 2000 of the Catalogue of Galactic PNe: 1510

Our Catalogue:
We used TOPCAT, an interactive VO tool, and gathered data from 30 already published catalogues and works. Finally:

2951 Galactic PNe
+ 121 misclassified PNe
A new Galactic PNe Catalogue

Catalogue of Galactic PNe

New and updated catalogue of Galactic PNe

Aller et al. (2016, in prep.)

SVOCat

2951 data found.

Aller et al. (2016, in prep.)
Exploiting archival data

- **OGLE** (Optical Gravitational Lensing Experiment):
  - Extensive I-band photometric database (LCO)
  - Limiting magnitude $I \sim 20$

- **Kepler**:
  - Space mission (high photometric precision)
  - Limiting magnitude $V \sim 16$

**Miszalski et al. (2009)**

**De Marco et al. (2015)**
Exploiting archival data

- **ASAS** (All Sky Automated Survey):
  - Two observing stations (LCO and Maui)
  - Monitoring stars brighter than $V \sim 14$

- **OMC** (Optical Monitoring Camera):
  - Monitoring stars brighter than $V \sim 18$

- **SuperWASP** (Wide Angle Search for Planets):
  - Two observatories (ING and SAAO)
  - Magnitude range $V \sim 7-15$

- **Catalina Sky Surveys**
  - Three telescopes (2 Arizona + 1 Australia)
  - Limiting magnitude $V \sim 21$
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Mas-Hesse et al. (2003)
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*Pollacco et al. (2006)*
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Preliminary results (known binaries)

Be UMa

This work

Shimanskii et al. (2008)

P_{orb} = 2.29 days
Preliminary results (known binaries)

LSS 2018

This work

Hilditch et al. (1996)

\[ P_{\text{orb}} = 0.357 \text{ days} \]
Preliminary results (known binaries)

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This work

Afsar & Ibanoglu (2008)

$P_{\text{orb}} = 0.472$ days
Preliminary results (new candidates)
Preliminary results (new candidates)
Preliminary results (new candidates)
Search for infrared excess

34 objects in total
Search for infrared excess

Upload your own data file (max size=500Kb)

It must comply with the required data format
(A small utility is available to help you to convert an original file in ascii (csv) or votable to VOSA input format)

File to upload: Seleccionar archivo  Ningun archivo seleccionado
Description: 
File type: Flxes (erg/cm2/s/A)  Flxes (3y)  Magnitudes

Create a single object data file

Just write the coordinates (in decimal degrees) of one object that you want to study and we will create a single object data file with the adequate format. RA and DEC are compulsory.

RA:  (deg)  DEC:  (deg)
Obj.Name:  Description:  Create
Search for infrared excess
Search for infrared excess

No binary detected

Hot star+ K type star
Preliminary results *(new candidates)*
Preliminary results (new candidates)
Preliminary results (new candidates)
The next step is to monitor the candidates by means of:

- Photometric survey
- Radial velocity survey
There are about 3000 confirmed Galactic planetary nebulae but... spectroscopic information of their central stars is available for only 13% of them!!! (Weidmann & Gamen 2011).
Coming soon

Aznar Cuadrado et al. (2004)

Napiwotzki & Schonberner (1995)
Summary

★ PNe are the late stage of low- and intermediate- mass stars ($\sim 0.8 - 8 \, M_\odot$)

★ **Binary** central stars: **key** to explain the complex and **non-spherical PNe**

★ Highly needed to **search for new binary CSPNe**. Four steps:

1. To have a **census of all CSPNe**: Build a catalogue

2. Search for **light curves in archival data**

3. Search for **infrared excess with archival photometry**

4. **Follow-up the candidates** to confirm and characterize them by means of both photometric and radial velocity observations
Gracias!