Abstract
We are carrying out research to determine the pulsation period of low-mass stars’ life cycles called Proto-Planetary Nebulae (PPNe). The datasets come from our Valparaiso University Observatory (VUO), as well as the All Sky Automated Survey – All Sky Catalogue (ASAS-ASC), and the All Sky Automated Survey for Supernova (ASAS-SN). These datasets complement each other to ensure that we get high-quality data for our very faint objects over long intervals of time in both hemispheres. Observations for this project have been carried out at VUO for 25 years. The ASAS-ASC and ASAS-SN data recently became open to the public and we are using them in our analysis. We are using these three datasets to search for periodic photometric variability in 48 evolved stars. We do this by using a sophisticated period search program called Period04. Our research has found 18 objects that have one or more significant periods ranging from 37 to 208 days.

Data Reduction

- The PPNe stage is the stage between red giants and white dwarfs
- PPNe are wrapped in dust cocoons left over from mass ejected during the AGB phase
- PPNe pulsates due to gravitational instability, causing the star to vary in brightness
- Light variation is on the range of 35 to 208 days
- PPNe stage lasts for about 1000 years

Observations
Valparaiso University Observatory (VUO)
- 0.4 meter Cassegrain telescope
- CCD camera, 2008 – Present
- Red (R), Visual (V), and Blue (B) filters

ASAS-ASC
- 2 telescopes, down to 14th mag faintness
- 2000 – 2009 data
- V filter, lower precision, search for long term trends

ASAS-SN
- 20 telescopes worldwide
- V filter, 2015 – Present, down to 17th mag
- High frequency observations, high precision
- Supplementary to our datasets

Period Analysis
To analyze the data that we have taken, we use a program called Period04 (P04). P04 is a program designed to fit data sets with multiple sine functions simultaneously. Using a Fourier calculation method, it can superimpose multiple functions to complex light curves. It gives periods and their significance compared to background noise. Uncertainties are calculated by a least-squares method. Our objects have periods between 35 and 200 days. Light curves of IRAS 20000, IRAS 04296, IRAS 19386, and IRAS 22223 and frequency spectrums are shown below as an example.

Results
Some results from the V filter shown in table below.

<table>
<thead>
<tr>
<th>Object</th>
<th>Periods (Uncertainties) days</th>
<th>P1/P2</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRAS 04296+3429</td>
<td>53.3 (0.1), 71.5 (0.1)</td>
<td>0.75</td>
</tr>
<tr>
<td>IRAS 05113+1347</td>
<td>154.3 (0.4), 207.9 (0.4)</td>
<td>0.74</td>
</tr>
<tr>
<td>IRAS 07253+2001</td>
<td>73.8 (0.1), 73.3 (0.1)</td>
<td>1.01</td>
</tr>
<tr>
<td>IRAS 07430+1115</td>
<td>137.9 (0.5), 116.2 (0.6)</td>
<td>1.19</td>
</tr>
<tr>
<td>IRAS 17279-1119</td>
<td>90.22 (0.001), 90.20 (0.001)</td>
<td>1.00</td>
</tr>
<tr>
<td>IRAS 18095+2704</td>
<td>103.4 (0.1), 99.0 (0.2)</td>
<td>1.04</td>
</tr>
<tr>
<td>IRAS 19386+0155</td>
<td>105.6 (0.2), 116.8 (0.7)</td>
<td>0.90</td>
</tr>
<tr>
<td>IRAS 20000+3239</td>
<td>132.9 (0.3), 154.6 (0.6)</td>
<td>0.86</td>
</tr>
<tr>
<td>IRAS 20136+1309</td>
<td>146.5 (0.5), 84.4 (0.3)</td>
<td>1.74</td>
</tr>
<tr>
<td>IRAS 22223+4327</td>
<td>86.6 (0.1), 91.1 (0.1)</td>
<td>0.95</td>
</tr>
<tr>
<td>IRAS 22227+5435</td>
<td>131.6 (0.1), 112.7 (0.2)</td>
<td>1.17</td>
</tr>
<tr>
<td>IRAS 23034+6147</td>
<td>81.6 (0.2), 87.4 (0.3)</td>
<td>0.93</td>
</tr>
</tbody>
</table>

Periods are found and compared to results from other datasets.

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References