How Astronomers Measure Distance: Cepheid Variables

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INTRODUCTION

Cepheid Uses / History
- Measuring universal distance
- Discovered by Henrietta Leavitt

How Cepheids Work
- Cepheid’s are related by their period and luminosity
  - Maximum change in brightness over a certain time
  - Period-Luminosity Relationship: the longer the period the more luminous the star
- Outer layers expand/contract in a cycle that changes the star’s luminosity

SAMPLE CALCULATION

- Equations Used:
  - $M_v = -1.371 - 2.986 \times \log(P)$
  - $d = 10^{(u/5+1)}$
  - $u = m - M_v$

- Sample Calculation for One Star:

<table>
<thead>
<tr>
<th>STAR: RT Auriga</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M_v = -1.371 - 2.986 \times \log(3.728190)$</td>
</tr>
<tr>
<td>$M_v = -3.077493139$</td>
</tr>
<tr>
<td>$d = 10^{(8.523493139/5) + 1)}$</td>
</tr>
<tr>
<td>$d = 507$ parsecs</td>
</tr>
</tbody>
</table>

METHODS / PROGRAMMING

- Calculates the absolute magnitude of the Cepheid given in the database

```java
public static double calculateAbsoluteMagnitude(double[] database, int line) {
    return database[line];
}
```

- Measures distance in parsecs using absolute and apparent magnitude

```java
public static double calculateDistance(double[] database, int line) {
    double d = Math.pow(10, (u/5+1));
    return database[line];
}
```

CONCLUSIONS

Issues Found in Research
- Some period-luminosity equations used amplitude and others did not
- Different equations use different constants

Drawbacks to Cepheid Variables
- Not actually very bright; they can not be seen from far away or when obstructed
- Speed of light means the further away you see, the further back in time you see

Current Uses
- Stellar evolution
- Our aim was to help collegiate-level students understand Cepheid Variables

Why a Program:
- Automates the distance calculations
- Allows for the data to be found in a large database
- Useful for data analysis of Cepheids
- Could be used for comparing distance calculations in different databases in future work

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REFERENCES


Leavitt, Henrietta. "The Variable Stars of the Algol Type." 1908AnHar..60..109L Page 113, adsbit.harvard.edu/cgi-bin/nph-iaarticle_query?bibcode=1908AnHar..60..109L&db_key=AST&page_ind=4&plate_select=NO&data_type=GIF&type=SCR EEN_GIF&classic=YES.

