

# The ULB Binary-Star Modelling Project



Robert Izzard



Lionel Siess



Tyl Dermine

# The ULB Binary-Star Modelling Project

## Why binaries?

- ▶ Many (most?) stars are in binaries
- ▶ Accurate stellar parameters (L, R, M,  $T_{\text{eff}}$ )
- ▶ Exotic evolution
- ▶ Pulsations! Ejections!  
Accretion! Explosions!



# ULB Stellar Research



	Single Stars	Binary Stars
Observations:	M,MS,S (AGB)	Ba, CH, CEMP
Surveys:	GAIA	GAIA
Modelling:	Single Stars (STAREVOL) Nucleosynthesis	

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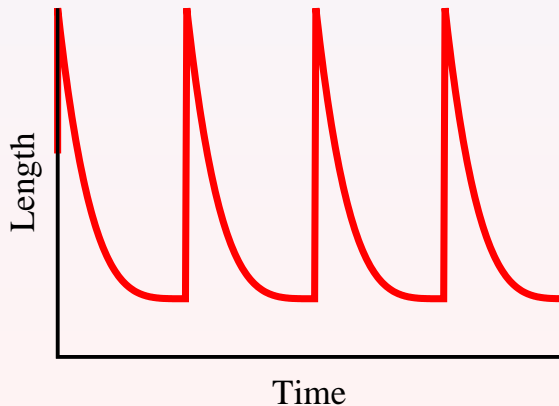
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# Scientific challenges

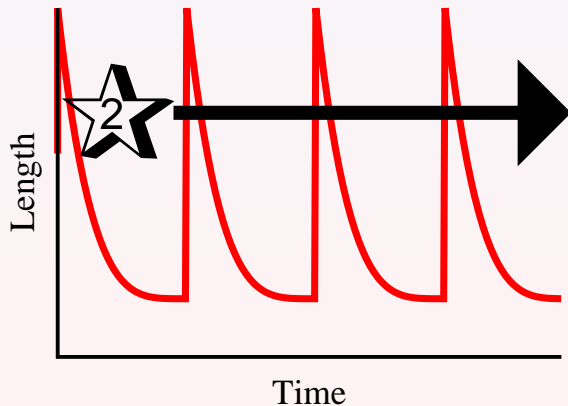
- ▶ Focus on low- and intermediate-mass binary stars
- ▶ AGB mass transfer : Ba, CH, CEMP, post-AGB





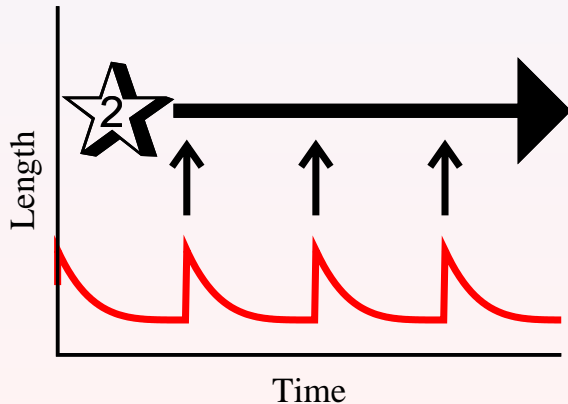
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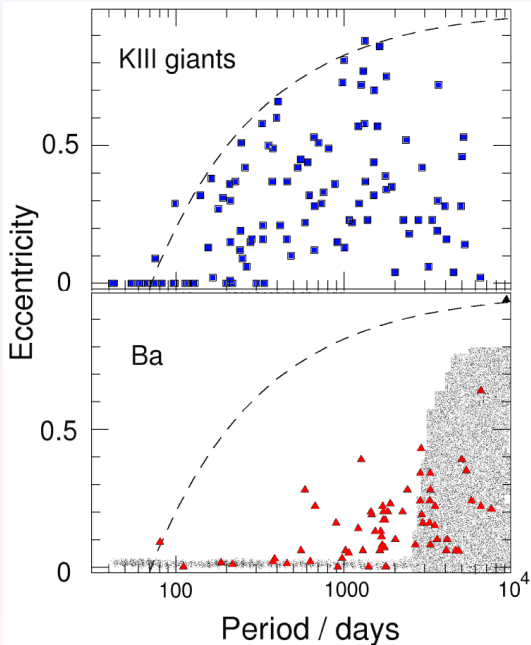


# Scientific challenges

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- ▶ AGB mass transfer : Ba, CH, CEMP, post-AGB



e.g. Barium stars



# STAREVOL (Lionel's code)

- ▶ Reliable, well-tested single-star evolution code
  - ▶ Derived from Kippenhahn's original code
  - ▶ via Forestini etc.
  - ▶ State-of-the-art input physics
  - ▶ Detailed nucleosynthesis
- ▶ (S)AGB calculations, planetary accretion, rotational and gravity wave mixing etc.

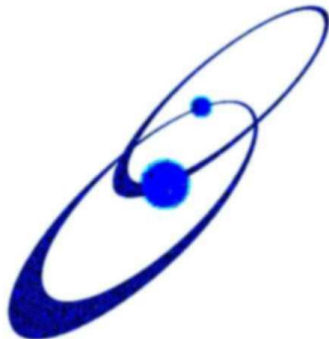


```
*****
*                               *
*   |     EVOLUTION OF THE STARS   |   *
*   |                               |   *
*   |                               |   *
*   |                               |   *
```

PROGRAM starevol

# Binary STAREVOL (Binstar? Binevol?)

- ▶ Complete rewrite!
  - ▶ FORTRAN 77→90, Modular
  - ▶ Numerical improvements
- ▶ Current status:
  - ▶ (most) Code reorganised
  - ▶ Evolves two stars at once
  - ▶ Basic mass transfer/orbital evolution
  - ▶ Working on the binary interaction physics (RLOF/wind/disc interaction)
  - ▶ Needs a better name!



\*\*\*\*\*

```
*          =====          *
*          |  EVOLUTION OF BINARY STARS  |          *
*          =====          *
*          PROGRAM binevol          *
```

# Technological challenges

- ▶ Two stars → > twice as slow
- ▶ Parallel computing is the future
  - ▶ Quad-core CPU now
  - ▶ 8-thread CPU now
  - ▶ Open-MP parallelisation
- ▶ Graphics card: 100s of threads
  - ▶ Double precision now/soon
  - ▶ New scientific libraries
  - ▶ Cheap!



# Final Remarks

- ▶ Binary-star code ready soon:
  - ▶ Tests new physics (e.g. wind/disc-interactions)
  - ▶ Self-consistent detailed AGB binary models!
  - ▶ Complements observational surveys
  - ▶ Harness new technology