

# HARMONIC AND SIMPLE HARMONIC MOTION

PHYS 2302, Saint Mary's University

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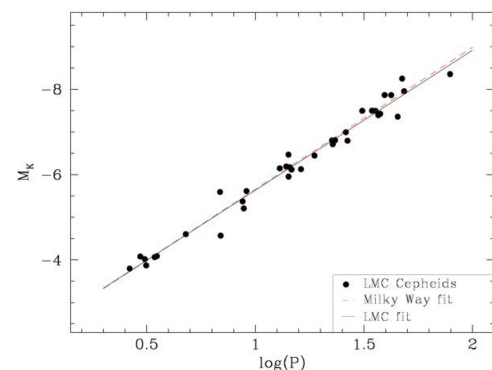
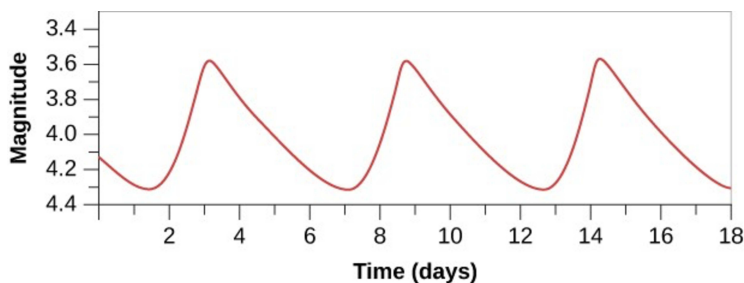
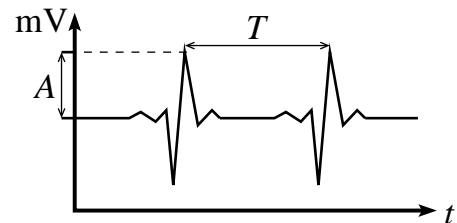
**Definition.** *Harmonic motion:* Any repetitive process that exhibits:

- a regular *period*  $T$  (time for motion to repeat itself), and thus a regular *frequency*  $f = 1/T$  (number of periods per second);
- a well-defined *amplitude*,  $A$ , where  $T$  may or may not depend upon  $A$ .

If the oscillation can be described by a sine (or cosine) wave,  $T$  is independent of  $A$  and the system is said to undergo *simple harmonic motion*.

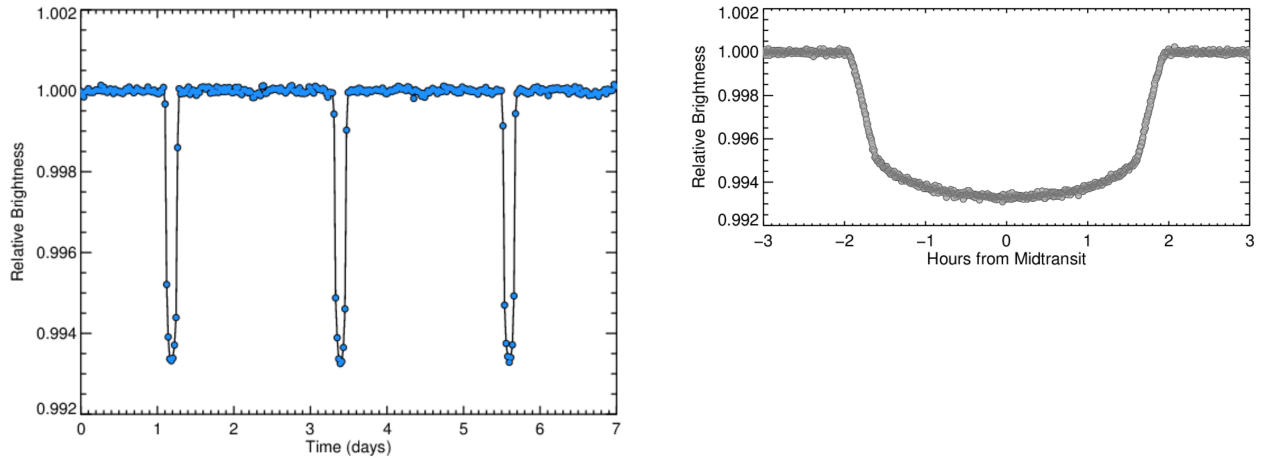
## Examples.

1. the human heartbeat: harmonic motion
2. Cepheid variables: harmonic motion



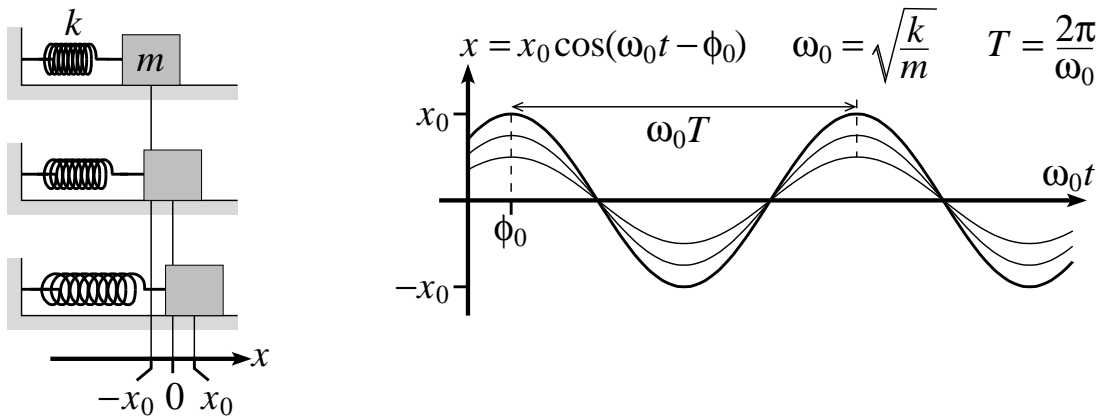
- pulsating stars (expand/contract and thus brighten/dim with periods of 3–200 days) whose  $\log(\text{absolute luminosity})$ ,  $M_K$ , is proportional to  $\log(\text{period})$  of brightness variation.
- discovered by Henrietta Swan Leavitt in 1908
- a critically important distance calibrator for the “cosmic ladder”

### 3. Exoplanet light curves: harmonic motion



- brightness variation caused by planet “transiting” its star
- slope at edges of “dip” indicative of planet diameter
- width of “dip” indicative of distance from star

### 4. Mass on a spring: $F = -kx = m\ddot{x}$ , *simple* harmonic motion



- angular frequency,  $\omega_0$ , and period,  $T$ , independent of amplitude,  $x_0$
- motion/oscillation described by a cosine-wave
- phase,  $\phi_0$ , indicates where oscillator starts at  $t = 0$