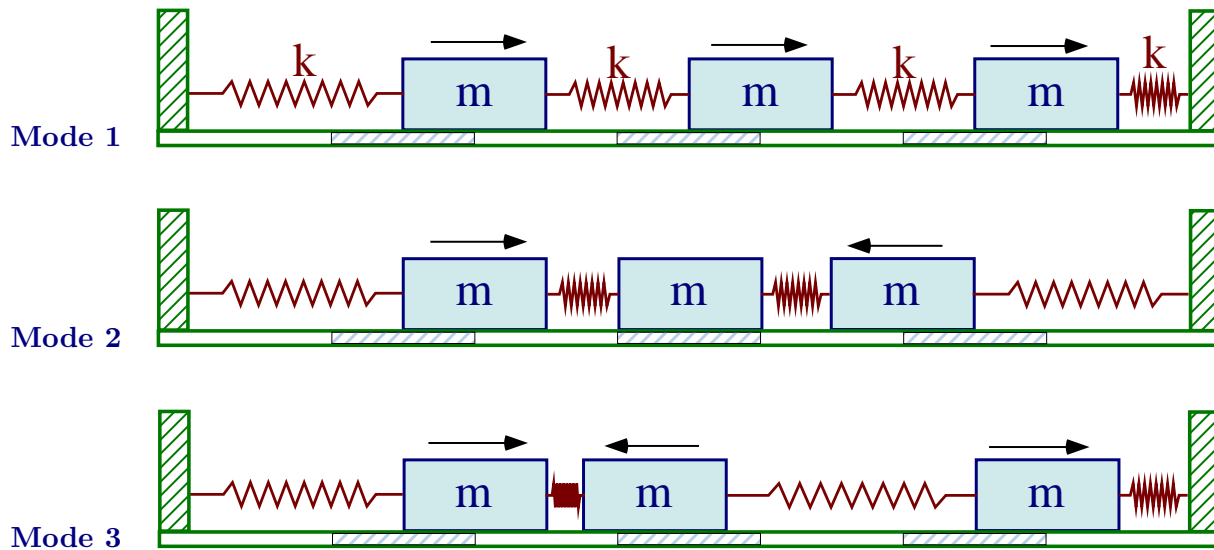


23.5 Mode dance

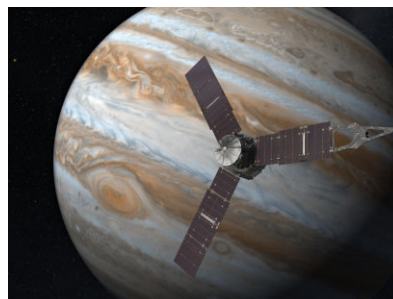
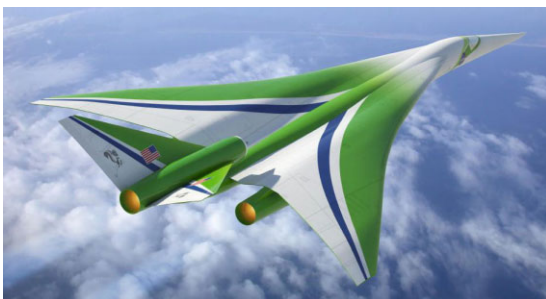
A *mode* is a manner of motion. This section gives a physically meaningful demonstration of eigenvalues and eigenvectors (mode/motion shapes) of a simple three particle system connected by springs.⁴



Under the columns labeled “Eigenvalue,” “Kinetic Energy,” and “Total Energy,” circle or write **small**, **medium**, or **large**. Under the column labeled “Eigenvector,” write **+**, **0**, or **–**.

Mode #	Eigenvalue (frequency)	Eigenvector (use +, 0, or –)	Potential Energy ($\frac{1}{2} k \delta^2$)	Kinetic Energy ($\frac{1}{2} m v^2$)	Total Energy
1	small medium large	$\begin{bmatrix} + \\ + \\ + \end{bmatrix}$ or $\begin{bmatrix} - \\ - \\ - \end{bmatrix}$	small /medium/large 2/3/4 deformed springs small deformation	small /medium/large small speed 1/2/3 particles moving	small medium large
2	small medium large	$\begin{bmatrix} + \\ 0 \\ - \end{bmatrix}$ or $\begin{bmatrix} - \\ 0 \\ + \end{bmatrix}$	small/ medium /large 2/3/4 deformed springs medium deformation	small/ medium /large medium speed 1/2/3 particles moving	small medium large
3	small medium large	$\begin{bmatrix} + \\ - \\ + \end{bmatrix}$ or $\begin{bmatrix} - \\ + \\ - \end{bmatrix}$	small/medium/ large 2/3/4 deformed springs large deformation	small/medium/ large large speed 1/2/3 particles moving	small medium large

Answers at www.MotionGenesis.com \Rightarrow [Textbooks](#) \Rightarrow [Resources](#).



Coupled ODEs arise from structural vibration problems, e.g., in aircraft, spacecraft, turbines, bridges, ...

⁴The mode dance can be done with three people, each who act out a particle’s motion and together imitate each mode of the three particle system. Alternately, it can be done individually with two fists (one particle on either side of your head) and your head (middle particle). Music may accompany each mode. The 1st mode song has a slow beat (e.g., Enya’s Caribbean Blue). The 2nd mode song has a medium beat (e.g., Star Wars). The 3rd mode song has a fast beat (e.g., William Tell Overture).