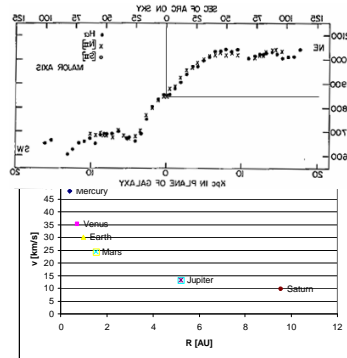


## Dark Matter—14 Nov

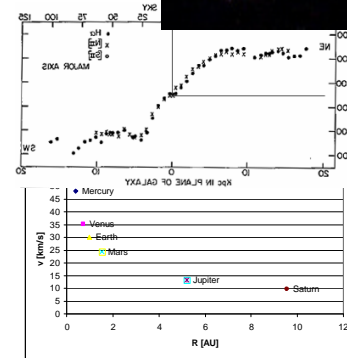
- Where is the mass? Is the mass all in the center of the galaxy?
  - K's 3<sup>rd</sup> Law  
 $M(R) \propto v^2 R$
  - Hypothesis: Mass of NGC 3672 is all at center. Assume speed @ 16kpc is 180km/s.
1. What is speed at 2kpc if hypothesis is true. Is actual speed at 2kpc & mass within 2kpc higher or lower than that of hypothesis?



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## Where is the mass?

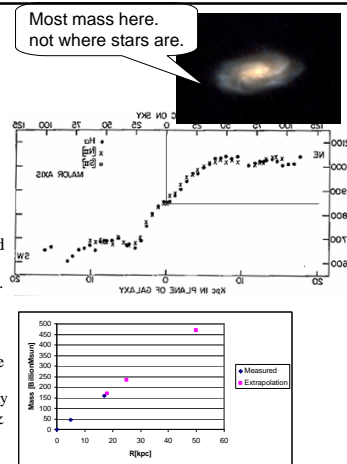
- $M(R)$  is mass enclosed within radius  $R$ .
  - K's 3<sup>rd</sup> Law  
 $M(R) \propto v^2 R$
2. Sketch  $M(R)$  for the solar system. ( $M_{\text{Jupiter}} = 0.001 M_{\text{Sun}}$ ).
  - NGC3672
    - $v(R)$  rises from 0 to 7 kpc.
    - $v(R)$  is constant beyond 7kpc.
  3. Sketch  $M(R)$  for Galaxy NGC3672.
  4. What would you expect for  $M(R)$  beyond 20 kpc? Justify your guess.



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- $M(R)$  is mass enclosed within radius  $R$ .
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  - $v(R)$  rises from 0 to 7 kpc.
  - $v(R)$  is constant beyond 7kpc.
- 3. Sketch  $M(R)$  for Galaxy NGC3672.
- 4. What would you expect for  $M(R)$  beyond 20 kpc? Justify your guess.
- Between 7 & 16 kpc,  $M(R)$  rises linearly.
- There is little light beyond 7 kpc.
- Where there is mass there is not necessarily light from stars & gas.
- Extrapolate  $M(R)$  is linear beyond visible part of galaxy.
  - This is tested with satellites of Milky Way
- Most of mass of galaxies is not in stars & gas.



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## Summarizing Question

5. Simplicio reasons, “The evidence for dark matter is really weak. How can you measure dark matter when you cannot see it.” Answer Simplicio.

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