The Rotation of Spiral Galaxies

Vera C. Rubin, 1983, Science, 220, 4604

Outline

- Brief history of evidence for dark matter
- Early evidence of flat rotation curves in galaxies
- Article: Flat curves for various Hubble types and luminosities
- Conclusions

Historical Evidence

- Dark matter in MW disk: Kapteyn (1922), Oort (1960)
- Motions of galaxies in clusters: Zwicky (1933, 1937), Smith (1937), ...
- Motion of galaxy groups: Kahn & Woltjer (1959), Peterson (1979)
- Rotation curves of galaxies: Babcock (1939), Rubin & Ford (1970), ...
- X-ray measurements in clusters: Matthews (1978), Fabricant et al. (1980), ...

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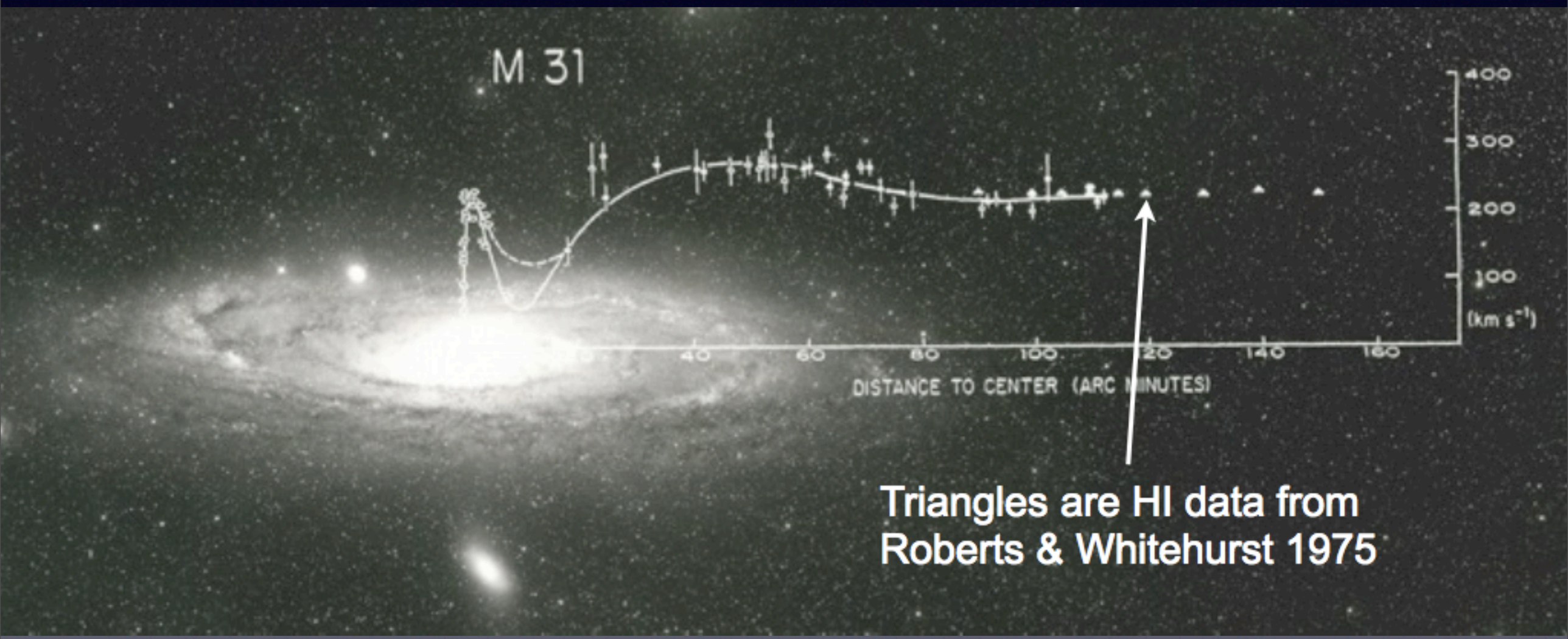
Early Measurements of Flat Rotation

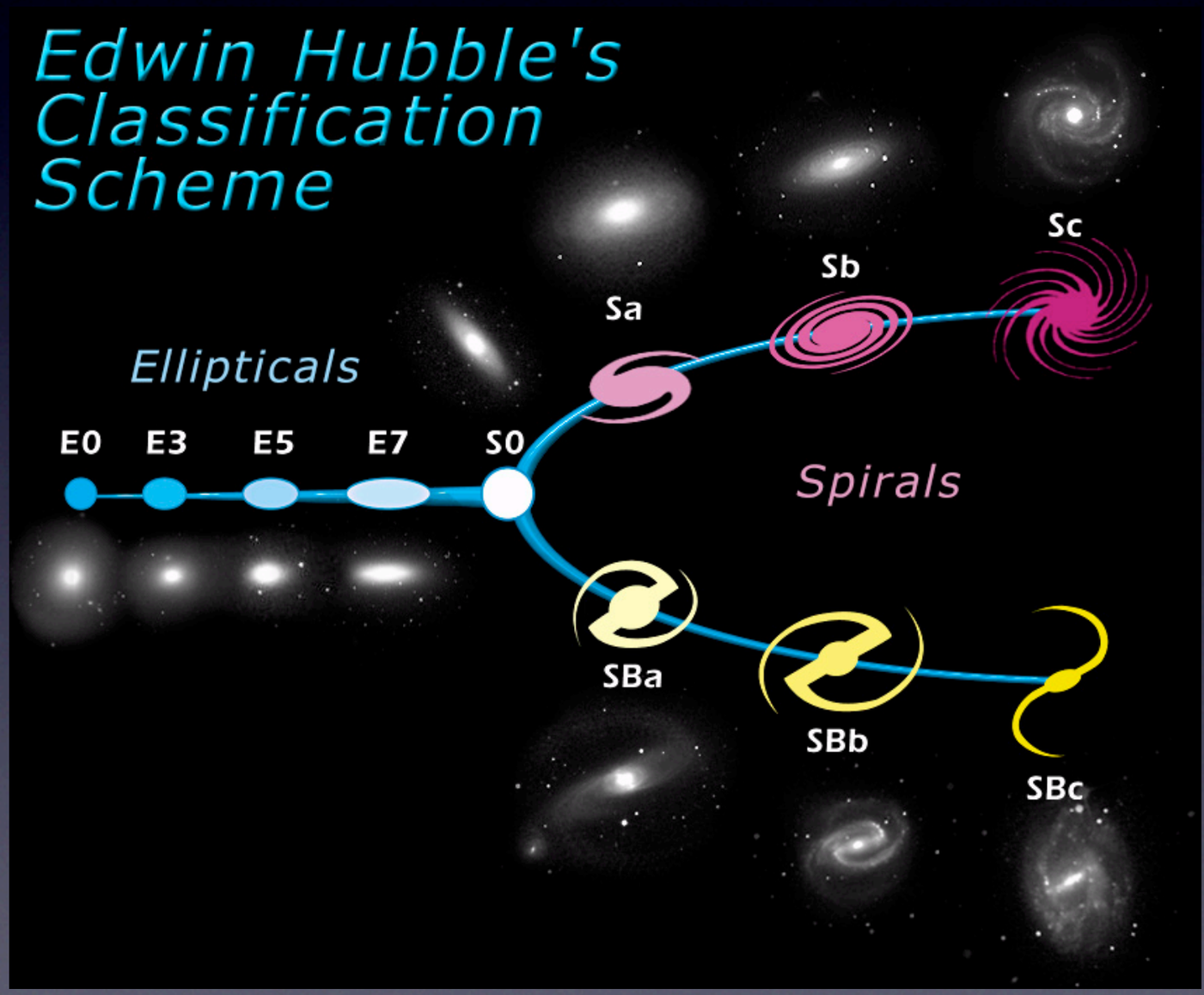
Rubin & Ford, 1970, ApJ, 159, 379



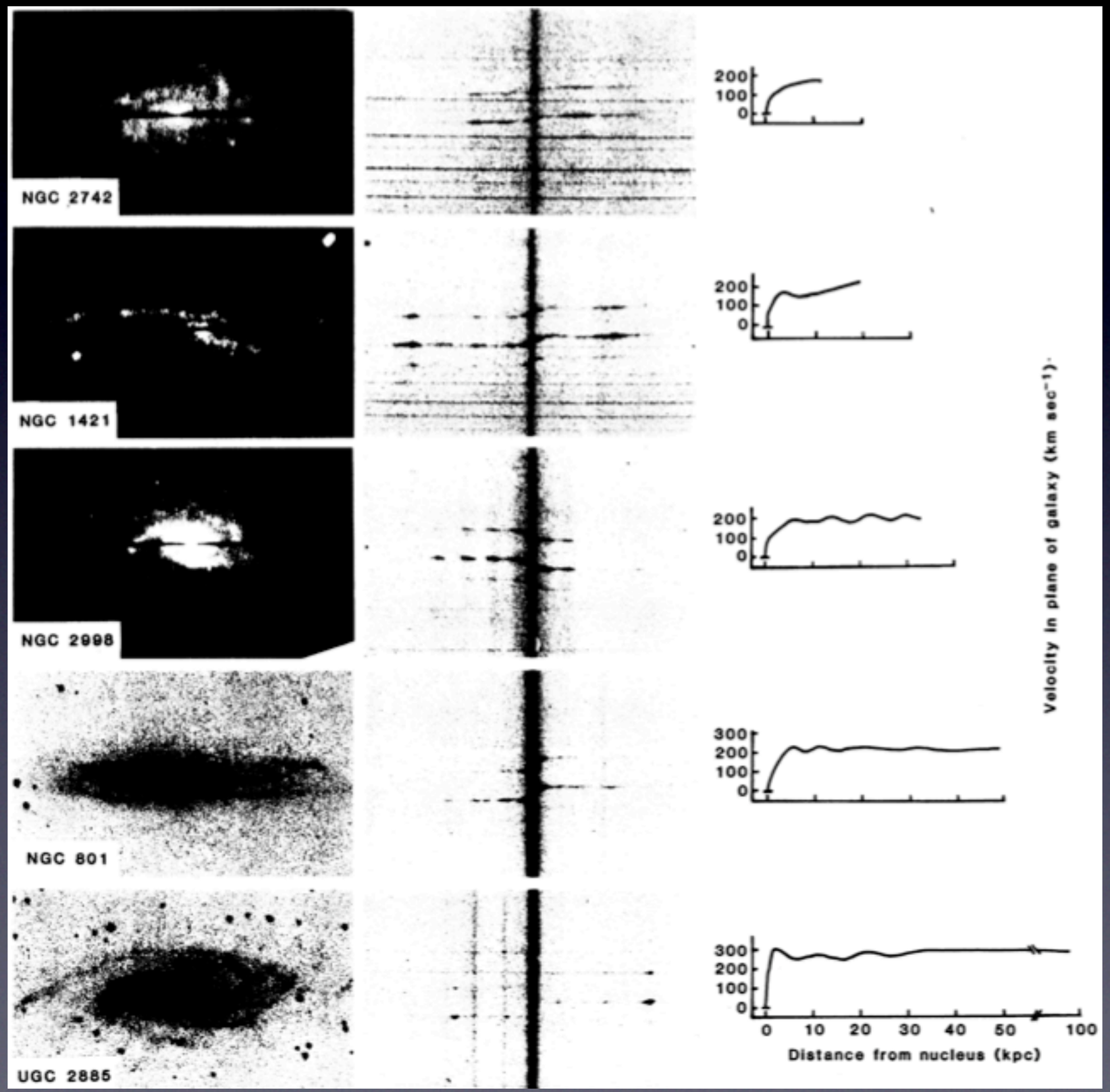
Courtesty: Joel Primack

Flat Rotation Curves

- Expanded sample (1983), rotation curves of 60 spiral galaxies
- Sample contains a variety of Hubble types: Sa, Sb, and Sc (no bars)
- Expanded range in luminosities of targets

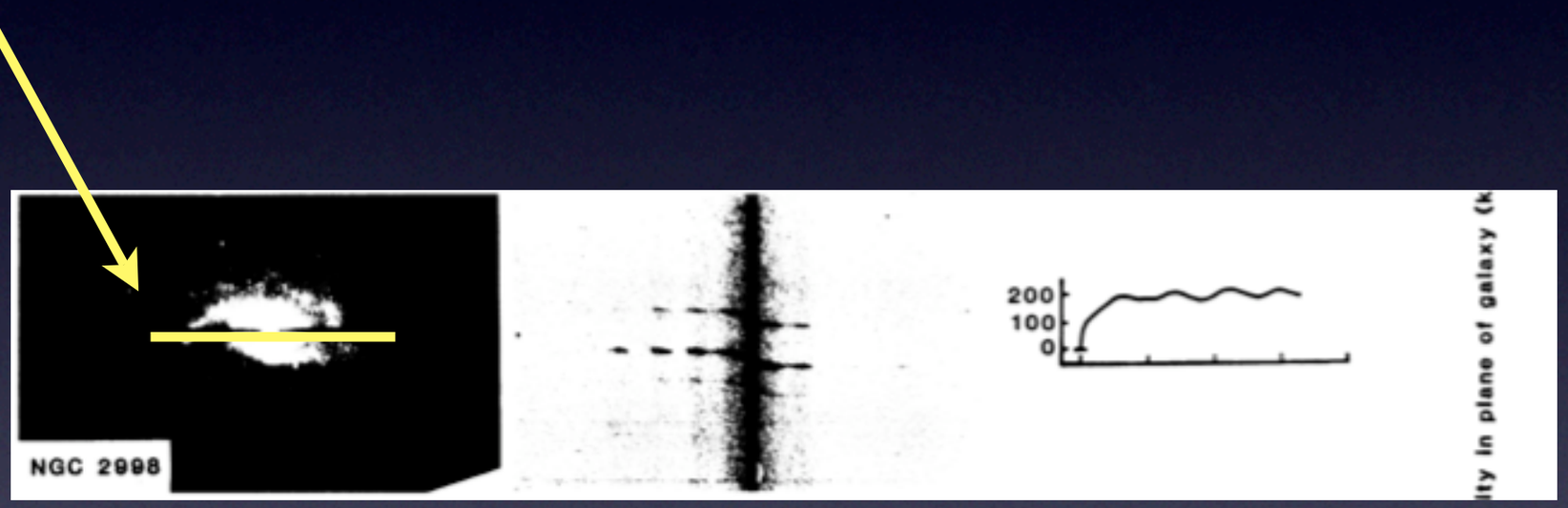


Measuring Rotation



Measuring Rotation

Put down a slit



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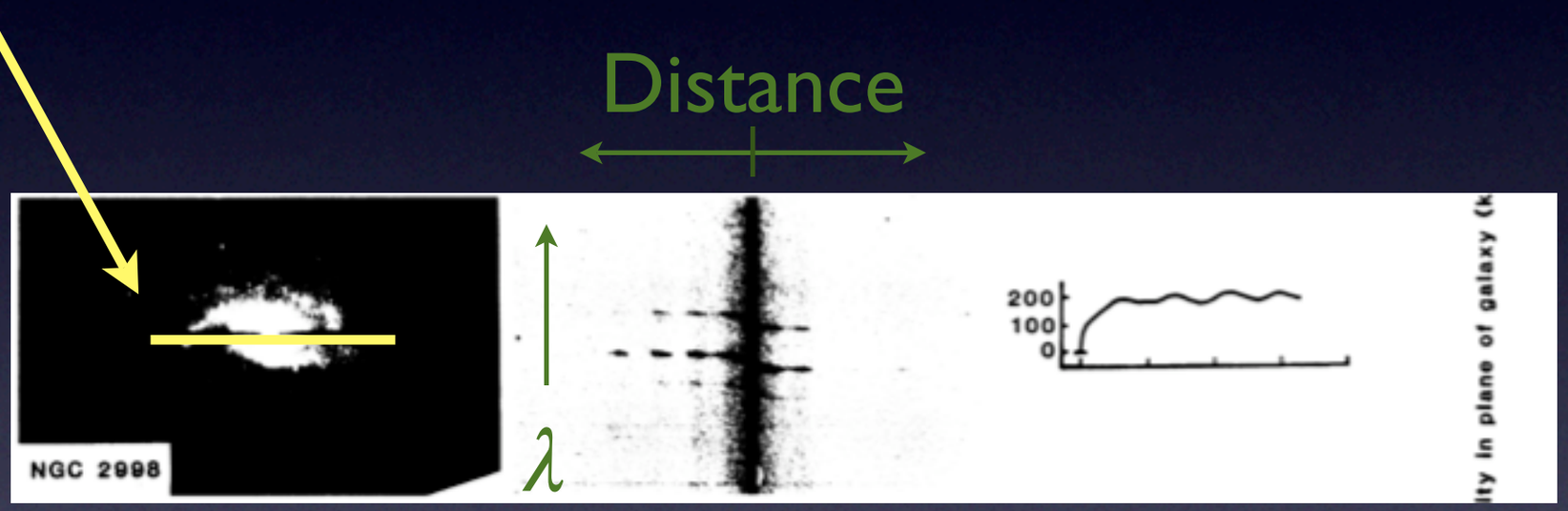
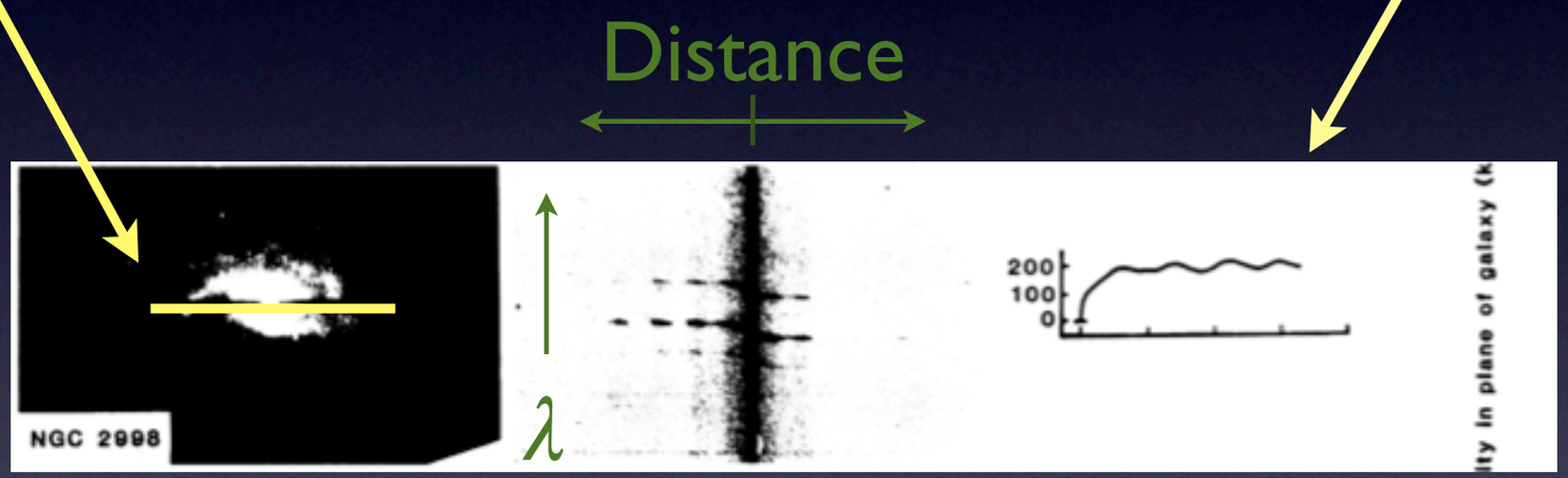


Record a spectrum

Measuring Rotation

Put down a slit

Plot Rotation Curve



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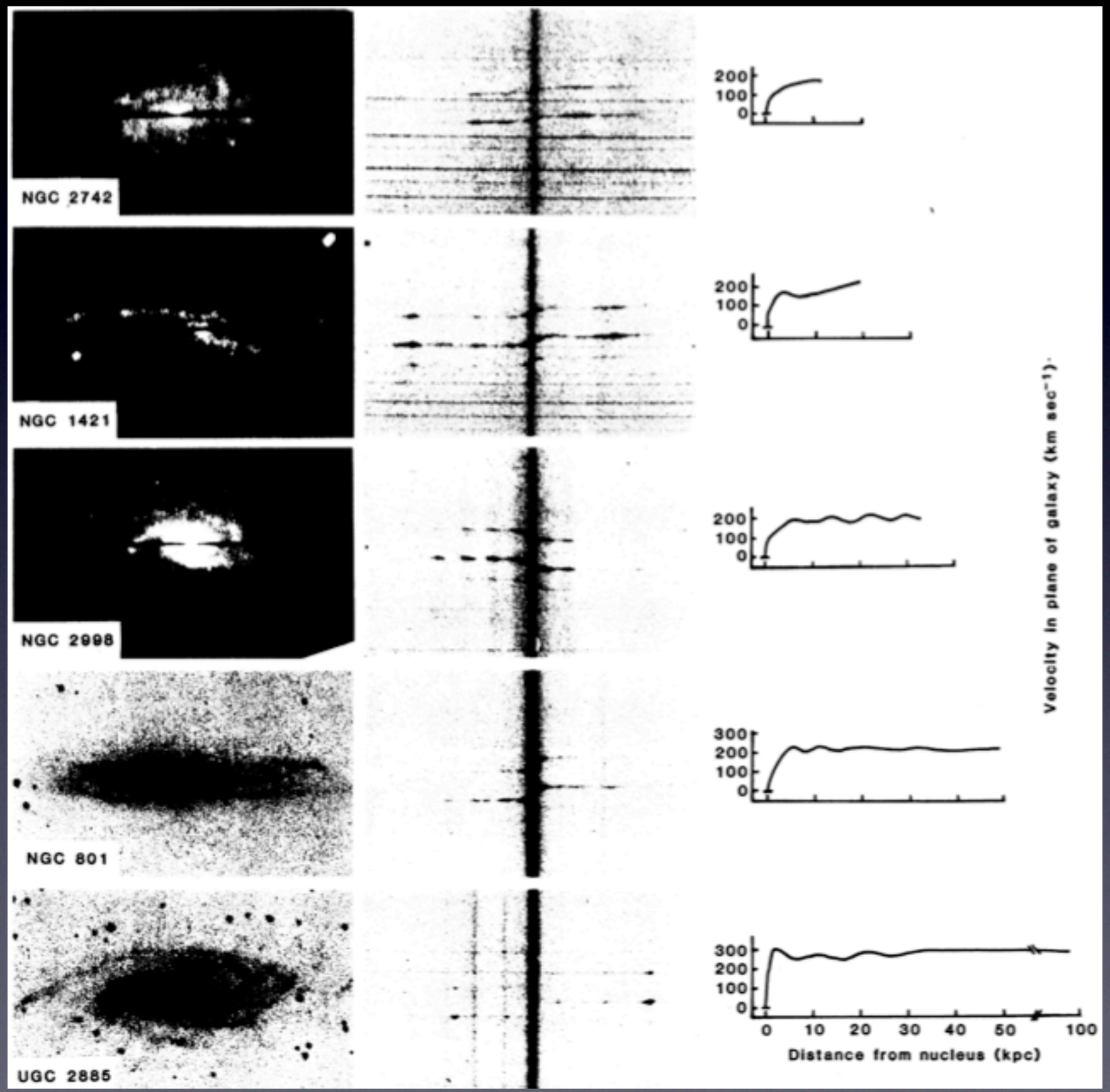
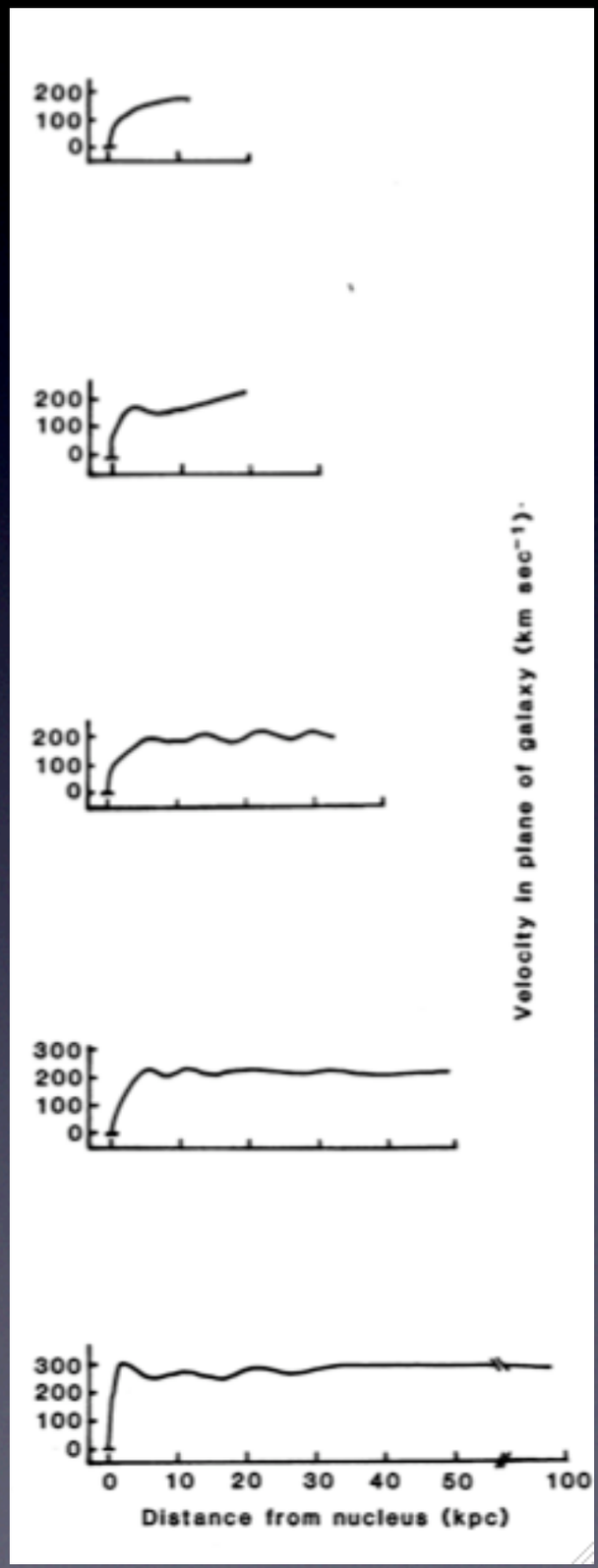


What does it imply?

- Flat rotation curves; regardless of Hubble type, luminosity



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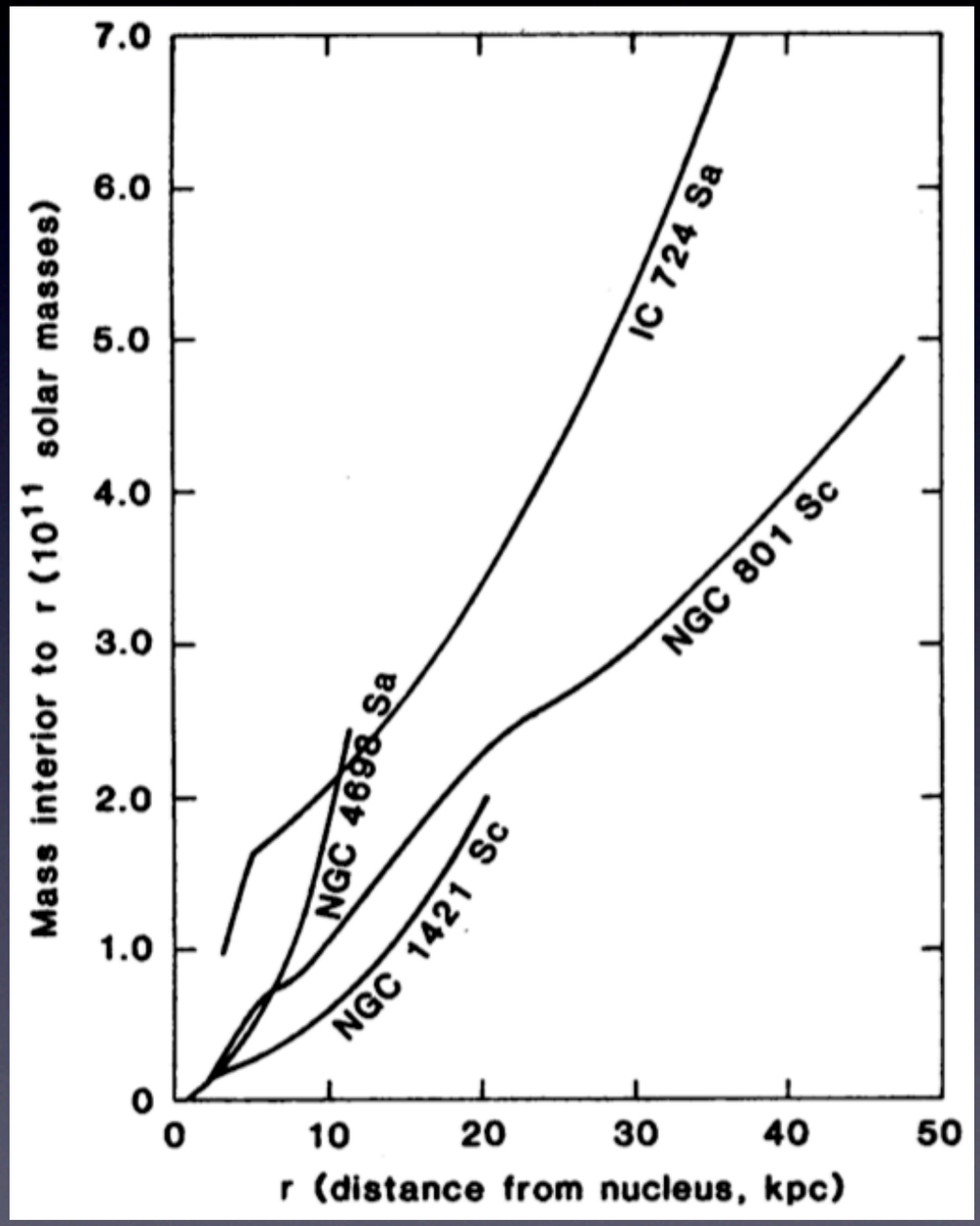

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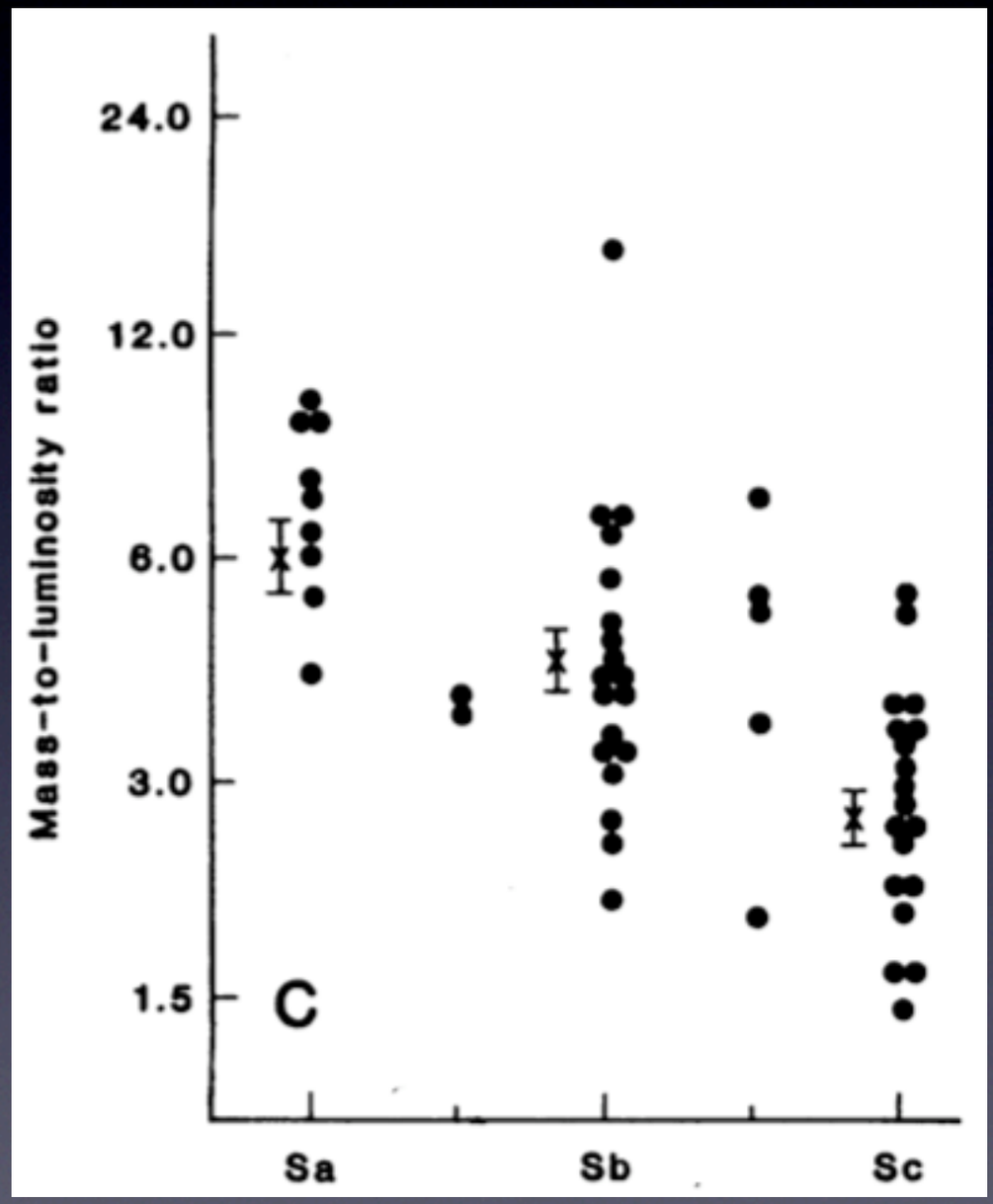

Conclusions

- Rotation curves in spiral galaxies are roughly flat, regardless of Hubble type or total luminosity.

- These curves (and inferred M/L) extend beyond the luminous mass, implying galaxies are embedded in a dark halo.