arXiv:1608.01749
arXiv:1706.05481

The Foreground Effect on the *J*-factor Estimation of Dwarf Spheroidal Galaxies

Shunichi Horigome (Kavli IPMU)

(Collaboration with Koji Ichikawa, Miho N. Ishigaki, Shigeki Matsumoto, Masahiro Ibe, Hajime Sugai, Kohei Hayashi)

Contents:

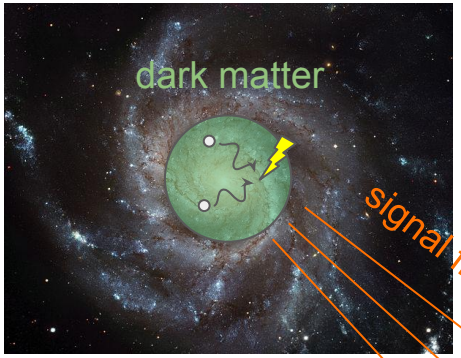
- Indirect detection and “J-factor”
- J-factor estimation of dSph
- Uncertainty of J-factor: foreground effect
- Our Analysis and Result
- Summary

arXiv:1608.01749
arXiv:1706.05481

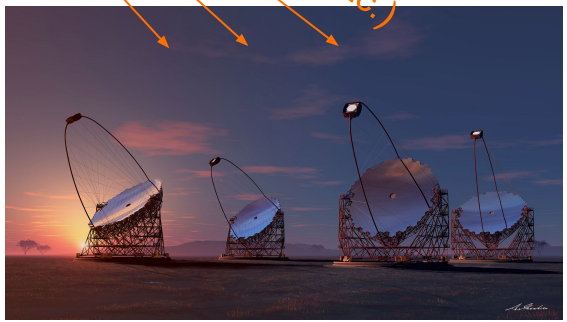
Indirect detection and “J-factor”

dSph:
Near from earth, DM dominant,
no other gamma-ray source

https://en.wikipedia.org/wiki/Spiral_galaxy



Fermi-LAT,
CTA, etc.



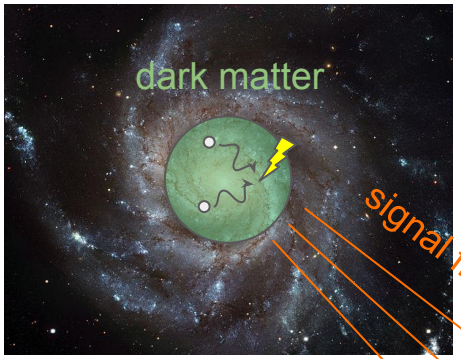
https://www.cta-observatory.org/project/technology/lst/

arXiv:1608.01749
arXiv:1706.05481

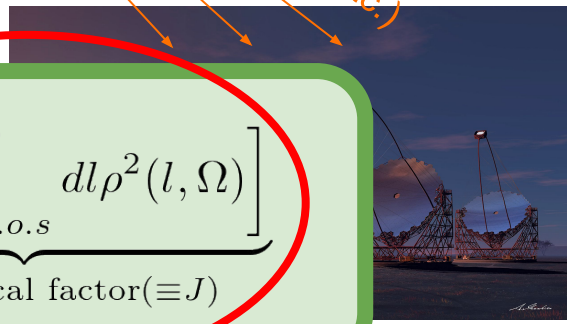
Indirect detection and “J-factor”

dSph:
Near from earth, DM dominant,
no other gamma-ray source

https://en.wikipedia.org/wiki/Spiral_galaxy



Fermi-LAT,
CTA, etc.



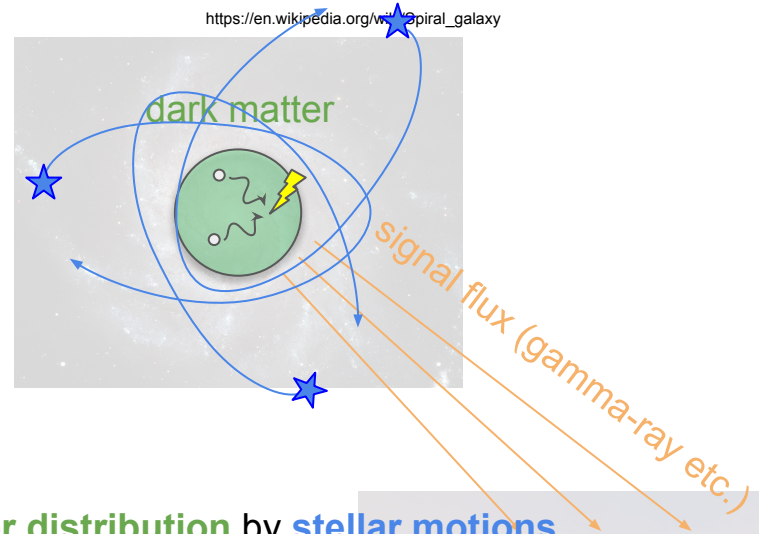
$$\Phi(E,\Delta\Omega) = \underbrace{\left[\frac{\langle\sigma v\rangle}{8\pi m_{\rm DM}^2}\sum_f b_f\left(\frac{dN_\gamma}{dE}\right)_f\right]}_{\text{particle physics factor}} \times \underbrace{\left[\int_{\Delta\Omega} d\Omega \int_{l.o.s} dl\rho^2(l,\Omega)\right]}_{\text{astrophysical factor}(\equiv J)}$$

arXiv:1608.01749
arXiv:1706.05481

J-factor estimation of dSph

dSph:
Near from earth, DM dominant,
no other gamma-ray source

https://en.wikipedia.org/wiki/Spiral_galaxy



Spectrograph: **PFS !**

★'s velocity is ...

http://pfs.ipmu.jp/ja/instrumentation.html

determine **dark matter distribution** by **stellar motions**

$$\frac{\partial(\nu_*(r)\sigma_r^2(r))}{\partial r} + \frac{2\beta_{\rm ani}\sigma_r^2(r)}{r} = -\frac{GM_{\rm DM}(r)}{r^2}$$

(stellar distribution & velocity dispersion) ~ (inner dark matter mass)

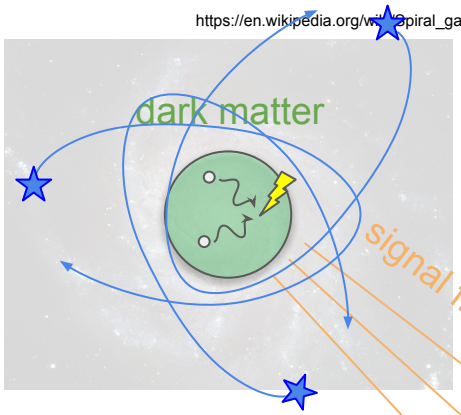
https://www.cta-observatory.org/project/technology/lst/

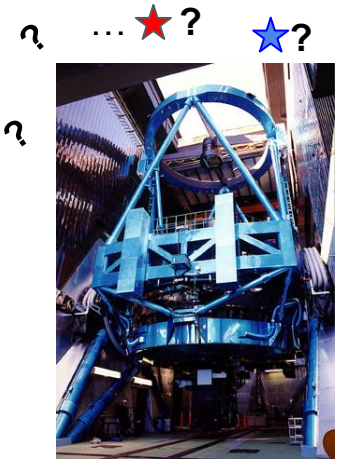
arXiv:1608.01749
arXiv:1706.05481

Uncertainty of J-factor: foreground effect

foreground star contamination

https://en.wikipedia.org/wiki/Spiral_galaxy





http://pfs.ipmu.jp/ja/instrumentation.html

determine **dark matter distribution** by **stellar motions**

$$\frac{\partial(\nu_*(r)\sigma_r^2(r))}{\partial r} + \frac{2\beta_{\rm ani}\sigma_r^2(r)}{r} = -\frac{GM_{\rm DM}(r)}{r^2}$$

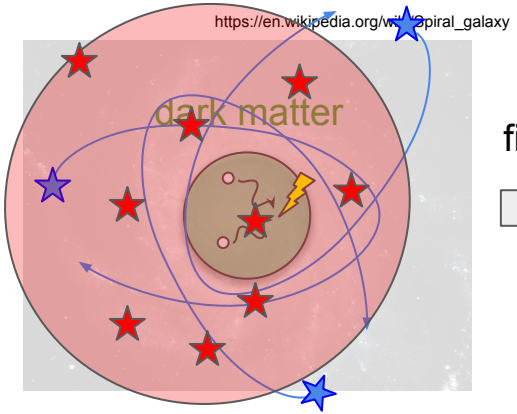
(stellar distribution & velocity dispersion) ~ (inner dark matter mass)

https://www.cta-observatory.org/project/technology/lst/

arXiv:1608.01749
arXiv:1706.05481

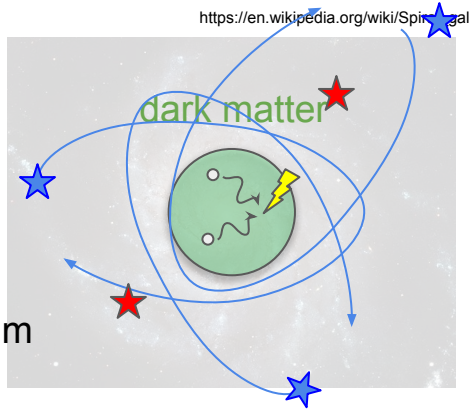
Our Analysis and Result

conventional method



filtering

EM algorithm

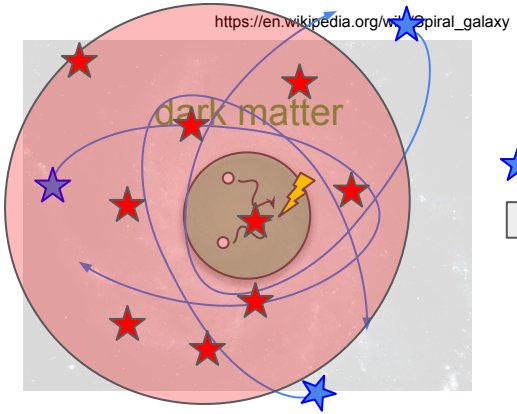


★ and ● 's model

parameter estimation: ●

dark matter ?

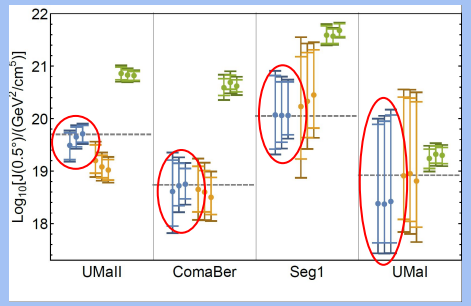
Our method (Mem+FG)



★, ★ and ● 's model

parameter estimation: ●

dark matter !



(------ :True)

arXiv:1608.01749
arXiv:1706.05481

Summary

- In the indirect detection of DM, accurate DM distribution of the target object (dSph) is required.
- Foreground contamination affects the J-factor estimation. Our analysis reduces this effect successfully thanks to the large FoV of PFS (1.3 degree).
- … Be careful for the J-factor values you adopt! (perhaps they will be updated!)

Danke!

- Future work:
  - Update the J-factor value of observed dSphs
  - other systematics (e.g. non-sphericity, anisotropy, etc.)