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I. Main objectives

- ✓ Perform comparisons of the BGM in the tangential directions to the spiral arms in the Galaxy
- ✓ Obtain the parameters of the spiral arms reproducing the color histograms (J-K) observed by 2MASS
- ✓ Employ a method of global optimization called Genetic Algorithms (GAs)

II. The Besançon Galaxy Model (BGM)

- ✓ Describes the galactic stellar content of the Galaxy (Robin et al. 2003):
 - Stellar evolution, galactic evolution, galactic dynamics. Available at:

<http://bison.obs-besancon.fr/modele/>

- ✓ Simulation results ⇒ output file. Ex: distances, color indices, magnitudes, etc...
- ✓ The components of the BGM: i-) thick disc (10 – 11 Gyr); ii-) thin disc (7 different populations 0 – 10 Gyr); iii-) bulge; iv-) halo (14 Gyr).
- ✓ In the present work, to use the BGM is also necessary:
 - Photometric errors (from 2MASS data): $\sigma_M = A + \exp(C_M - B)$
 - Completeness limit for each field (J, K)
 - Interstellar extinction obtained from: Amôres & Lépine (2005, see poster #2188), Marshall et al. (2006) and from the GAs (see section IV).

III. The Genetic Algorithms

- ✓ **Main characteristics:**
 - Uses the evolution principles and provide good and acceptable solutions
 - It is more robust than the traditional Monte Carlo Method
- ✓ **How does it work ?**
 - Create a sample of initial population
 - Calculate the fitness (χ^2) for each member using artificial selection; genetic crossover; mutation operator.
- ✓ **Some applications in astrophysics:**
 - Charbonneau (1995) ; Ng et al. (1998, 2002) ; Hakala (1995); McIntosh et al. (1998); Tomczyk et al. (1995) ; Charbonneau et al. (1998); Haywood (2002), Fletcher (2003), Parker et al. (2003), etc.
- ✓ **What version, we used ?**
 - PIKAIA (Paul Charbonneau, 1995). Available in FORTRAN and IDL.

IV. Obtaining the extinction from the Genetic algorithms

- ✓ We performed simulations using the BGM with $A_V = 0$ and compared the predicted color-histogram (J-K) with the observed one by 2MASS. Using the GAs, we adjusted 6 parameters: two to describe the diffuse extinction and four parameters to describe two clouds (A_V , distance). The Figure 1c shows the color histogram obtained after the adjustment of the interstellar extinction parameters.

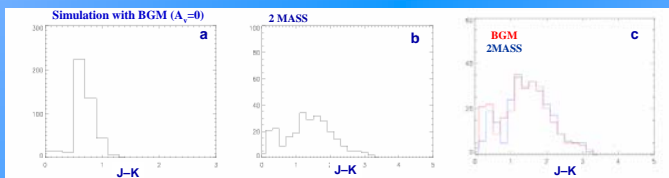


Figure 1. a-) Color histogram (J-K) predicted by the BGM for $l = -76.17^\circ$ and $b = 0.0^\circ$, b-) the observed one by 2MASS, c-) comparison between the observed and the obtained one after the adjustment of the extinction parameters.

V. Obtaining the 2MASS data

- ✓ **Choosing the tangential directions to the spiral arms :**
 - Data from the DIRBE/COBE experiment (IPAC)
 - Freudenreich (1996, 1998, 2004): subtraction of zodiacal contribution; punctual sources, conversion from ecliptic to galactic coordinates ...
 - 11 tangential directions (and 2 neighbors) ⇒ in the total, there are 33 regions.

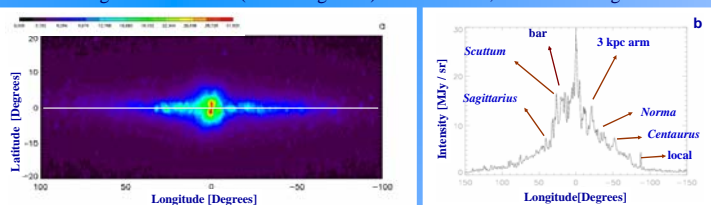


Figure 2. a-) Map of the intensity in the K band observed by DIRBE/COBE. b-) Longitudinal profile ($b=0^\circ$) in the K band in which the peaks are related to the tangential directions to the spiral arms.

VI. Method to determine the spiral arms parameters

- ✓ **How our method works ?**
 - Comparisons between the color histogram observed by the 2MASS and the predicted one by BGM in the spiral arms directions
 - If there is a difference between the star counts ⇒ adjustment of the spiral arms parameters (initial radius, inclination angle, phase, amplitude, width).
 - ✓ **Parameters adjusted:** $\theta_0, r_0, i, A, w, r_{ini}$ → 22 parameters
- ↓
begin of the spiral contribution

Since, we consider that only the young stars are located in the spiral arms. The spiral arms parameters acts only in these stars (stars with Age class $\leq 2 = 1$ Gyr). We consider a Galaxy with four main spiral arms + local arm.

VII. Some color-histogram obtained after the global optimization

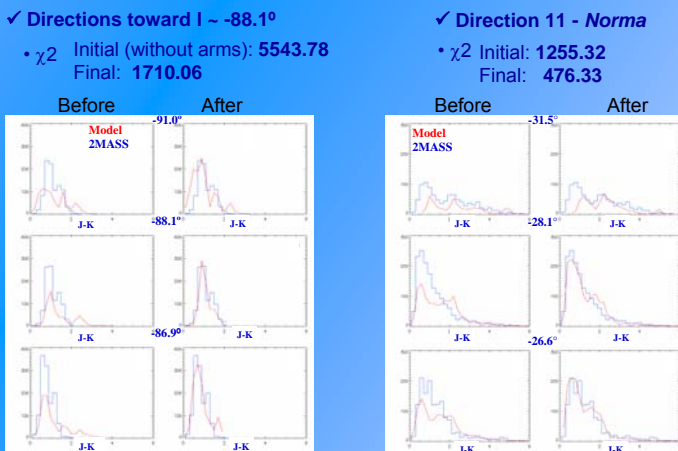


Figure 3. Color-histogram (J-K) obtained before and after the utilization of the global optimization method.

VIII. Spiral arms parameters

- ✓ The geometrical parameters of the spiral arms obtained after the adjustments and the Galaxy face-on representation..

	r (kpc)	θ	i ($^\circ$)
1	3.500	5.879	11.8
2	3.721	2.603	12.5
3	3.559	1.449	13.0
4	3.985	4.622	13.0
5	8.320	5.984	11.6

Table 1. Spiral arms parameters.

- **Pitch angle:**
 - Vallée (2002) $\langle i \rangle = 11.70 \pm 1.0^\circ$
 - $\langle i \rangle = 12.02 \pm 0.51^\circ$

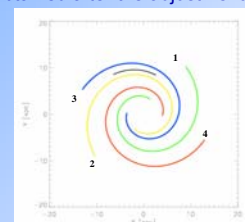


Figure 4. Face-on aspect.

- ✓ We also determine the radius of the galactic bar: $r = 3.427 \pm 0.347$

IX. References

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