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Mass-Luminosity Relations of Very Low Mass Stars

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Abstract. We present new accurate masses at the bottom of the main sequence as well as an improved empirical mass-luminosity relation for very low mass stars in the visible and near infrared. Masses were obtained by combining very accurate radial velocities and adaptive optics images of multiple stars obtained at different orbital phases.

1. Introduction

Mass is the most basic characteristic of a star. At a given age and metallicity, stellar structure and evolutionary models must reproduce its luminosity and radius. This is why empirical mass-luminosity relations (hereafter M/L) are fundamental astrophysical quantities to check our understanding of stellar physics. Furthermore, M/L is essential to convert the observed stellar luminosity into the mass function. Until recently, the M/L relation was poorly constrained for very low mass stars which prevented the comparison between observations and modelisations.

We already determined the masses of 20 M dwarfs (Ségransan et al., 2000) and a very accurate M/L relation (Delfosse et al., 2000) but these results are now improved by the addition of 8 new accurate masses ranging from 0.1 $M_\odot$ to 0.6 $M_\odot$.

2. Observations

Multiple stars from the solar neighborhood were observed by combining three complementary observational techniques with detection domains that cover all separations and mass ratios. First, very high accuracy radial velocity are obtained with the ELODIE spectrograph at Observatoire de Haute Provence (Delfosse et al., 1999). Second, adaptive optics imaging observations are conducted with PUE'O at CFHT (Delfosse et al., 1999) and third, near infrared long baseline interferometry observations are done at IOTA (Ségransan et al., in preparation).

3. Orbital elements determination

For orbital periods between 1 years and 10 years we are able to measure both radial velocities and angular separation. The quality of these data allows us to compute masses with an accuracy that range between 0.2% and 5% (Forveille et al., 1999 for the method).

4. Nine new accurate masses and absolute magnitudes

Id	$M_\odot$	M_V	M_J	M_H	M_K
LHS224A	0.117±0.003	14.2±0.1	-	9.04±0.05	8.77±0.04
LHS224B	0.111±0.002	14.5±0.2	-	9.27±0.05	8.90±0.04
Gl381A	0.416±0.002	10.6±0.1	7.08±0.04	6.45±0.03	6.27±0.03
Gl381B	0.285±0.001	11.8±0.2	7.78±0.05	7.43±0.03	7.12±0.04
Gl487Aa	0.280±0.002	11.9±0.3	-	-	-
Gl487Ab	0.275±0.002	11.9±0.3	-	-	-
Gl487B	0.270±0.002	12.0±0.3	8.26±0.2	7.43±0.04	7.14±0.03
Gl586Aa	0.97±0.03	-	-	3.92± 0.08	3.72±0.06
Gl586Ab	0.63±0.02	-	-	5.2± 0.1	5.2±0.1

5. Mass-luminosity relations

As predicted by stellar structure models, the metallicity dispersion of the field populations induces a large scatter around the mean V band relation, while the infrared relations are much tighter. The agreement of the observed infrared M/L relations with the theoretical relations of Baraffe et al. (1998) is impressive, while we find an increasingly significant discrepancy in the V band for decreasing masses.

6. Conclusion

In the long term effort to determine accurate empirical mass luminosity relations at the bottom of the main sequence we have computed 28 accurate masses ranging between 0.1 and 0,6 $M_\odot$. The present mass-luminosity relations are now precise enough to exhibit discrepancies with theoretical models. The visible relation is off by 0.1 magnitude and presents a lot of dispersion which is probably caused by metallicity effects.

More accurate masses and metallicities must be computed to understand the discrepancies between the theoretical and empirical relations. The VLTI will be a perfect tool that will double the number of accurate masses the bottom of the main sequence by resolving short period spectroscopic binaries.

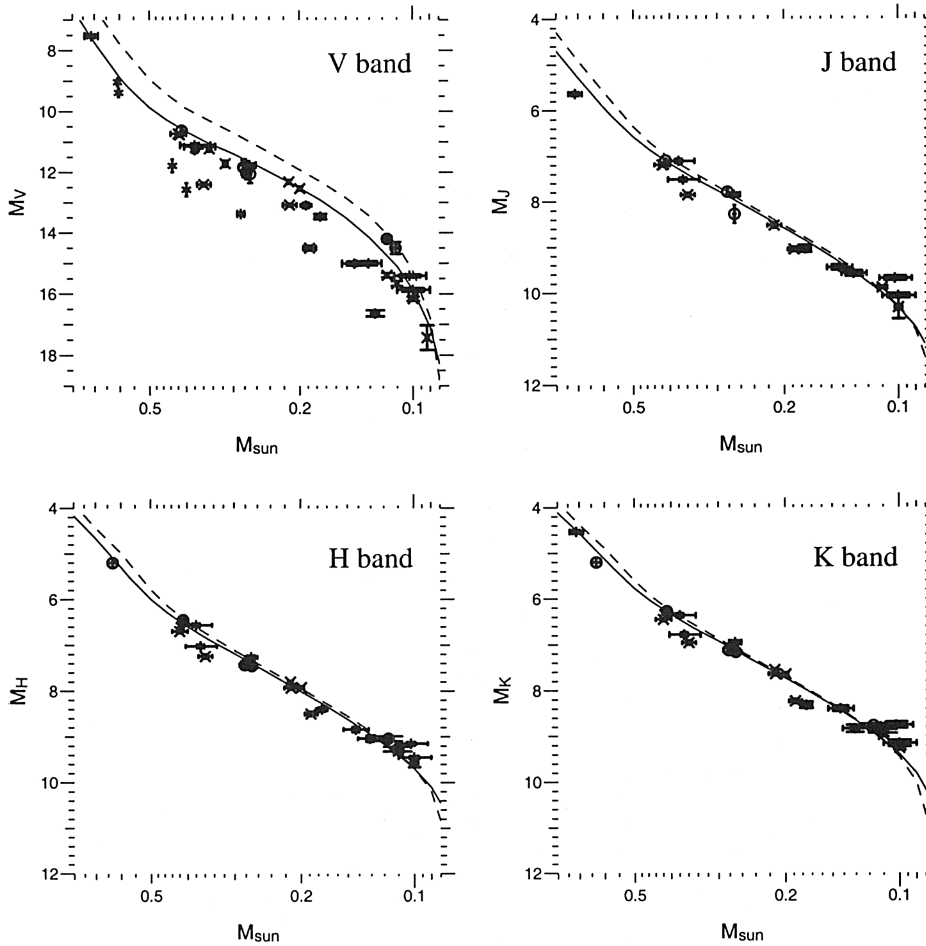

Figure 1. Comparison between V, J, H and K band observational and theoretical Mass-Luminosity relations. The two curve correspond to 5Gyr isochrone from Baraffe (1998). The dash line correspond to [M/H]=-0.5 and the plain line corresponds to [M/H]=-0.0. The circles correspond to the new masses

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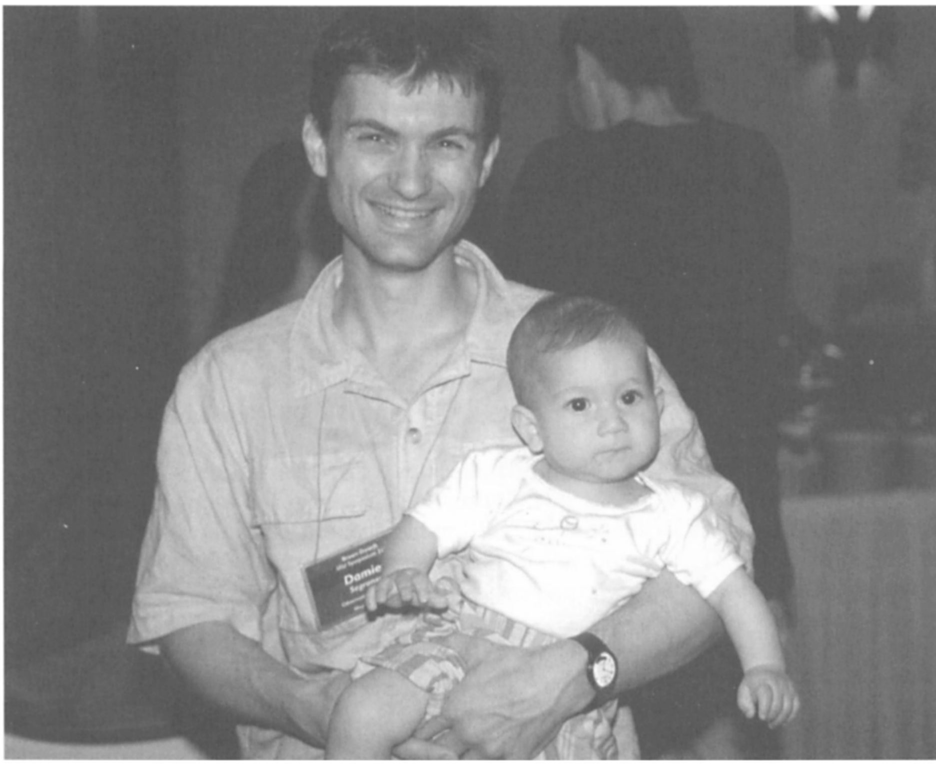

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