LINE PROFILES IN THE BULGE OF NGC7217

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ABSTRACT. Line-of-sight velocity distributions are becoming increasingly important for our understanding of galactic structure. We present results obtained for the bulge of NGC7217 with a new deconvolution technique.

1. The Need for Measuring Absorption Line Profiles in Galaxies

The stellar kinematics of three-dimensional systems are usually governed by three integrals of motion, and hence a three-dimensional data set is required to describe completely the intrinsically three-dimensional distribution function (DF). Even measurements of mean velocities and velocity dispersions over the entire face of a galaxy can never provide this much information: at best they yield several two-dimensional functions. Moreover, the rms velocity dispersion is never actually measured from galactic spectra: instead a measure of the line-broadening is obtained by assuming a particular (usually gaussian) line profile and finding the dispersion that best reproduces the spectrum. Since this may differ from the true rms dispersion of the stellar line-of-sight velocity distribution (LOSVD), it is not clear if use of these 'dispersions' in the Jeans equations is valid. Only more direct measurements of the LOSVD can help us decide. Measurement of the LOSVD over the face of a galaxy also provides the extra dimensionality in the data set which may eventually allow us to transcend the Jeans equations and get to the heart of the DF.

It has become increasingly feasible to measure the LOSVD directly, or at least to constrain it beyond measuring a best-fit gaussian (see van der Marel and Franx 1992 and refs. therein). Here we present a new method, based on quadratic programming (QP).

2. Line Profiles using Narrow Gaussians and QP

Any non-negative function which is smooth on scales below Δv can be approximated by a sum of gaussians with dispersion Δv and means v_i separated by $< 2\Delta v$ (the maximum separation for which there is no dip between the two peaks). If we write the LOSVD $f_{\mathbf{los}}$ as such a sum, a continuum-subtracted galaxy spectrum (assumed to be the doppler-shifted and -broadened spectrum S of a suitable late-type giant) should be a sum of copies of S with amplitude x_i, all broadened by the same gaussian dispersion Δv but shifted by different v_i. A least-squares fit of this model to the observed galaxy spectrum can then be formulated as a QP problem, and solved efficiently for x_i with a variation

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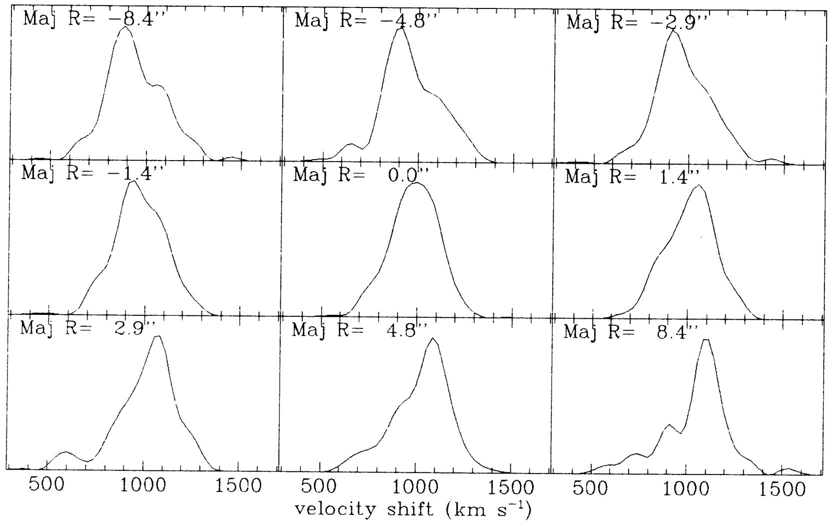
of the simplex algorithm. Positivity constraints on f_{los}, or indeed any other constraints linear in the x_i, can be built in easily, and if we choose the v_i such that they correspond to shifts of whole numbers of pixels, we only need to compute one convolution of the template.

Since the smoothing scale Δv can be set explicitly, our method falls somewhere between the parametric approach of van der Marel and Franx (1992) and the essentially non-parametric fit of Rix and White (1992). We have typically set Δv to two pixels, with adjacent gaussians shifted by three pixels.

3. Line Profiles in the Bulge of NGC7217

We have applied our method to deep (4hrs with the 3.9m CFHT), long-slit spectra of the Sab disk galaxy NGC7217, with $28\,\mathrm{km\,s^{-1}\,pixel^{-1}}$. Because of the moderate inclination of the galaxy (35°), all three velocity components project down the line of sight, raising hopes that a full solution for the three-dimensional kinematics of the system can be found.

The Figure shows our line profiles for the major axis of NGC7217. Note the large degree of consistency between opposite sides of the nucleus, the manifestly non-gaussian nature of almost all the major axis profiles, and the presence of around 30% of stars with apparently retrograde velocities in the outermost region of the bulge. The existence of retrograde stars in fact persists well out into the disk (Merrifield and Kuijken, in preparation).



References

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