Spiral patterns in the galaxy NGC 6946

M. Ehle

The most spectacular case of a detection of magnetic spiral arms is the Sc galaxy NGC 6946 where polarised radio emission, a tracer of the regular interstellar magnetic field, is concentrated in relatively narrow magnetic arms located *between* the optical arms (Beck & Hoernes 1996).

This observational result contradicts density-wave models predicting the strongest regular fields to be located within the optical spiral arms or at their inner edges. Also galactic dynamo models assume that the dynamo action is more intense within the optical spiral arms with the direct consequence of having stronger regular magnetic fields within them. As argued by Fan & Lou (1996), hydrodynamic waves may cause magnetic arms to be shifted in phase with respect to the density wave. This theory seems to be attractive to explain the phase shift but its relevance to real galaxies still remains unclear.

A naked-eye inspection cannot clarify whether the phase shift of the magnetic arms with respect to the optical ones is constant at all galactic radii. Hence a reliable determination of the pitch angles and phase shifts is essential for the understanding of the nature of magnetic arms. The wavelet analysis has obvious advantages compared to both naked-eye inspection of maps, where the eye tends to connect prominent albeit isolated small-scale features and can easily miss large-scale structures, and the Fourier analysis where only simple, symmetric structures can be studied successfully. We applied this technique to images of NGC 6946 in polarised and total nonthermal radio emission at $\lambda 6\,\mathrm{cm}$, in broadband red light, in the $\lambda 21.1\,\mathrm{cm}$ H I line and in the optical Hα line. The spiral pattern of NGC 6946 is most clearly visible in polarised radio emission (left panel) and red light (right panel). The magnetic arms are localised between the optical arms; the phase shift between the two appears to vary only little in the radial range 3–12 kpc and the pitch angles of the magnetic and optical spiral arms are generally close to each other.

R. Beck and *P. Hoernes:* Magnetic spiral arms in the galaxy NGC 6946, Nature., **379**, 47–49 (1996).

Z. Fan and *Y.Q. Lou:* Origin of the magnetic spiral arms in the galaxy NGC 6946, Nature., **383**, 800–802 (1996).

P. Frick, R. Beck, A. Shukurov, D. Sokoloff, M. Ehle and *J. Kamphuis:* Radio and optical spiral patterns in the galaxy NGC 6946, Mon. Not. R. Astron. Soc. submitted (1997).