Proceedings of the 7th European VLBI Network Symposium
Bachiller, R. Colomer, F., Desmurs, J.F., de Vicente, P. (eds.)
October 12th-15 2004, Toledo, Spain

EVN Observations of the Tintin⋆ & Snowy⋆⋆ Nebula

M. Ortadelo[1] and F. Ilemón[2]

[1] T.I.A., Rue del Percebe 13, E-00092 Castroforte del Baralla, Spain
[2] Astrological Institute, Mediaset, Via delle Stelle, I-66666 Milano, Italy

Abstract. The style file of this paper is very similar to the Astronomy & Astrophysics one. You can check for all their LaTeX commands in `http://www.edpscience.org/aa`. The contribution to this conference should be written in English. Colour figures are not supported.
You have 4 pages for an oral contribution, and 2 pages for a poster contribution. You have to upload the final PostScript file **before September 13th 2004** in the ftp directory
`ftp://ftp.oan.es/evn2004/`.
After that, you should mail to `evn2004@oan.es` to give us notice about the submission of the paper. The book with the proceedings will be distributed during the conference.

1. Introduction

Thompson et al. (1985) begin like that: "The techniques of radio interferometry as applied to astronomy and astrometry have developed enormously in the past four decades, and the attainable angular resolution has advanced from degrees to milliarcseconds, a range of over six orders of magnitude. As arrays for synthesis mapping have developed, techniques in the radio domain have overtaken those in optics in pfoviding the fi nest angular detail in astronomical images. The same general developments have introduced new capabilities in astrometry and in the measurement of the earth's polar and crustal motions. The theories and techniques that underlie these advances continue to evolve, but have reached by now a sufficient state of maturity that is appropriate to offer a detailed exposition." Some of the advances mentioned there may be reported in a paper like that, in the Proceedings of the EVN Symposium 2004.

Let's remember how was the sample fi le from A&A, to answer your questions about the style fi le: In the *nucleated instability* (also called core instability) hypothesis of giant planet formation, a critical mass for static core envelope protoplanets has been found. Mizuno (1980) determined the critical mass of the core to be about $12\,M_\oplus$ ($M_\oplus = 5.975 \times 10^{27}$ g is the Earth mass), which is independent of the outer boundary conditions and therefore independent of the location in the solar nebula. This critical value for the core mass corresponds closely to the cores of today's giant planets.

Although no hydrodynamical study has been available many workers conjectured that a collapse or rapid contraction will ensue after accumulating the critical mass. The main motivation for this article is to investigate the stability of the static envelope at the critical mass. With this aim the local, linear stability of static radiative gas spheres is investigated on the basis of Baker's (1966) standard one-zone model. Phenomena similar to the ones described above for giant planet formation have been found in hydrodynamical models concerning star formation where protostellar cores explode (Tscharnuter 1987, Balluch 1988), whereas earlier studies found quasi-steady collapse flows. The similarities in the (micro)physics, i.e., constitutive relations of protostellar cores and protogiant planets serve as a further motivation for this study.

⋆ Also known as Tintín, Tim or Kuifje
⋆⋆ Also known as Milú, Milou, Struppi, Terry, Bobby, Spunte or Boncuk

2. Baker's standard one-zone model

In this section the one-zone model of Baker (1966), originally used to study the Cepheïd pulsation mechanism, will be briefly reviewed. The resulting stability criteria will be rewritten in terms of local state variables, local timescales and constitutive relations. Baker (1966) investigates the stability of thin layers in self-gravitating, spherical gas clouds with the following properties:
- hydrostatic equilibrium,
- thermal equilibrium,
- energy transport by grey radiation diffusion.

For the one-zone-model Baker obtains necessary conditions for dynamical, secular and vibrational (or pulsational) stability (Eqs. (34a, b, c) in Baker 1966). Using Baker's notation:

M_r	mass internal to the radius r
m	mass of the zone
r_0	unperturbed zone radius
ρ_0	unperturbed density in the zone
T_0	unperturbed temperature in the zone
L_{r0}	unperturbed luminosity
$E_{\rm th}$	thermal energy of the zone

and with the defi nitions of the *local cooling time* (see Fig. 1)

$$\tau_{\rm co} = \frac{E_{\rm th}}{L_{r0}}\,, \tag{1}$$

and the *local free-fall time*

$$\tau_{\rm ff} = \sqrt{\frac{3\pi}{32G}\frac{4\pi r_0^3}{3M_{\rm r}}}\,, \tag{2}$$

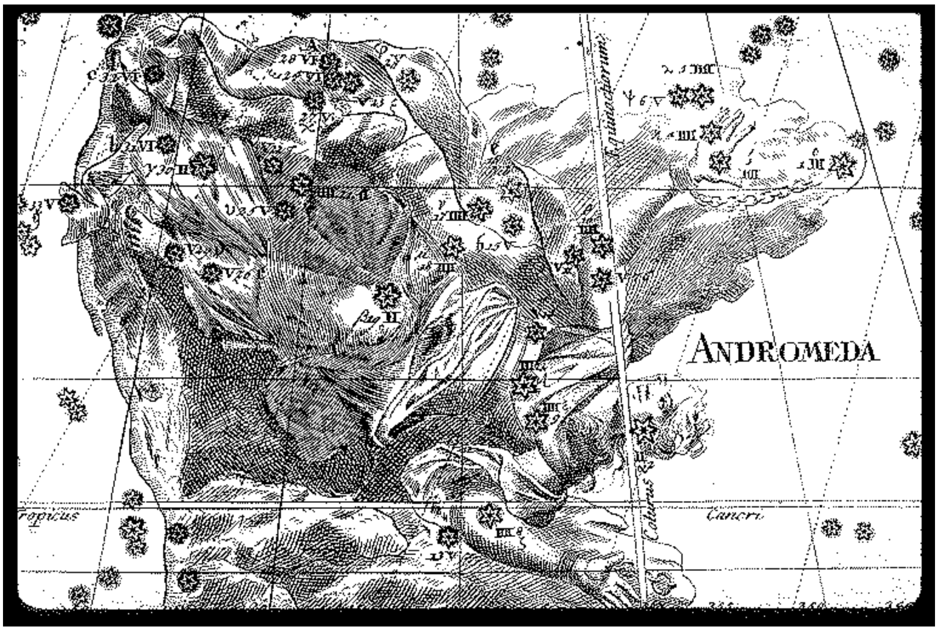


Fig. 1. Pre-EVN map of Andromeda, from Thomas (1730)

Baker's K and σ_0 have the following form:

$$\sigma_0 = \frac{\pi}{\sqrt{8}} \frac{1}{\tau_{\rm ff}} \quad (3)$$

$$K = \frac{\sqrt{32}}{\pi} \frac{1}{\delta} \frac{\tau_{\rm ff}}{\tau_{\rm co}}\,; \quad (4)$$

where $E_{\rm th} \approx m(P_0/\rho_0)$ has been used and

$$\begin{array}{l} \delta = -\left(\frac{\partial \ln \rho}{\partial \ln T}\right)_P \\ e = mc^2 \end{array} \quad (5)$$

is a thermodynamical quantity which is of order 1 and equal to 1 for nonreacting mixtures of classical perfect gases. The physical meaning of σ_0 and K is clearly visible in the equations above. σ_0 represents a frequency of the order one per free-fall time. K is proportional to the ratio of the free-fall time and the cooling time. Substituting into Baker's criteria, using thermodynamic identities and definitions of thermodynamic quantities,

$$\Gamma_1 = \left(\frac{\partial \ln P}{\partial \ln \rho}\right)_S , \; \chi_\rho = \left(\frac{\partial \ln P}{\partial \ln \rho}\right)_T , \; \kappa_P = \left(\frac{\partial \ln \kappa}{\partial \ln P}\right)_T$$

$$\nabla_{\rm ad} = \left(\frac{\partial \ln T}{\partial \ln P}\right)_S , \; \chi_T = \left(\frac{\partial \ln P}{\partial \ln T}\right)_\rho , \; \kappa_T = \left(\frac{\partial \ln \kappa}{\partial \ln T}\right)_T$$

one obtains, after some pages of algebra, the conditions for *stability* given below:

$$\frac{\pi^2}{8} \frac{1}{\tau_{\rm ff}^2} (3\Gamma_1 - 4) > 0 \quad (6)$$

$$\frac{\pi^2}{\tau_{\rm co}\tau_{\rm ff}^2} \Gamma_1 \nabla_{\rm ad} \left[\frac{1 - 3/4\chi_\rho}{\chi_T} (\kappa_T - 4) + \kappa_P + 1 \right] > 0 \quad (7)$$

$$\frac{\pi^2}{4} \frac{3}{\tau_{\rm co}\tau_{\rm ff}^2} \Gamma_1^2 \nabla_{\rm ad} \left[4\nabla_{\rm ad} - (\nabla_{\rm ad}\kappa_T + \kappa_P) - \frac{4}{3\Gamma_1} \right] > 0 \quad (8)$$

Table 1. Opacity sources.

Source	$T/[\mathrm{K}]$
Yorke 1979, Yorke 1980a	≤ 1700[a]
Krügel 1971	$1700 \leq T \leq 5000$
Cox & Stewart 1969	$5000 \leq$

[a] This is footnote a

For a physical discussion of the stability criteria see Baker (1966) or Cox (1980).

We observe that these criteria for dynamical, secular and vibrational stability, respectively, can be factorized into
1. a factor containing local timescales only,
2. a factor containing only constitutive relations and their derivatives.
The first factors, depending on only timescales, are positive by definition. The signs of the left hand sides of the inequalities (6), (7) and (8) therefore depend exclusively on the second factors containing the constitutive relations. Since they depend only on state variables, the stability criteria themselves are *functions of the thermodynamic state in the local zone*. The one-zone stability can therefore be determined from a simple equation of state, given for example, as a function of density and temperature.

We will now write down the sign (and therefore stability) determining parts of the left-hand sides of the inequalities (6), (7) and (8) and thereby obtain *stability equations of state*.

The sign determining part of inequality (6) is $3\Gamma_1 - 4$ and it reduces to the criterion for dynamical stability

$$\Gamma_1 > \frac{4}{3}\,. \quad (9)$$

Stability of the thermodynamical equilibrium demands

$$\chi_\rho > 0, \quad c_v > 0\,, \tag{10}$$

and

$$\chi_T > 0 \tag{11}$$

holds for a wide range of physical situations. With

$$\Gamma_3 - 1 = \frac{P}{\rho T}\frac{\chi_T}{c_v} > 0 \tag{12}$$

$$\Gamma_1 = \chi_\rho + \chi_T(\Gamma_3 - 1) > 0 \tag{13}$$

$$\nabla_{\rm ad} = \frac{\Gamma_3 - 1}{\Gamma_1} > 0 \tag{14}$$

we fi nd the sign determining terms in inequalities (7) and (8) respectively and obtain the following form of the criteria for dynamical, secular and vibrational *stability*, respectively:

$$3\Gamma_1 - 4 =: S_{\rm dyn} > 0 \tag{15}$$

$$\frac{1 - 3/4\chi_\rho}{\chi_T}(\kappa_T - 4) + \kappa_P + 1 =: S_{\rm sec} > 0 \tag{16}$$

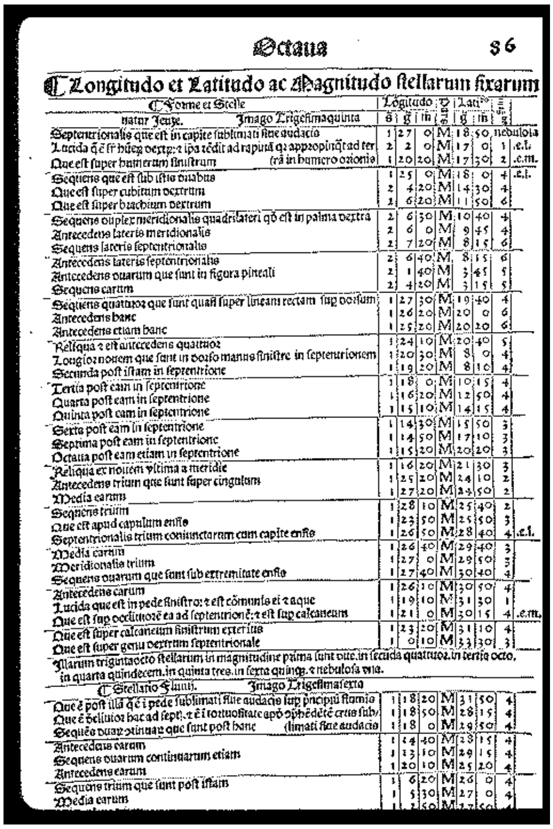
$$4\nabla_{\rm ad} - (\nabla_{\rm ad}\kappa_T + \kappa_P) - \frac{4}{3\Gamma_1} =: S_{\rm vib} > 0\,. \tag{17}$$

The constitutive relations are to be evaluated for the unperturbed thermodynamic state (say (ρ_0, T_0)) of the zone. We see that the one-zone stability of the layer depends only on the constitutive relations Γ_1, $\nabla_{\rm ad}$, χ_T, χ_ρ, κ_P, κ_T. These depend only on the unperturbed thermodynamical state of the layer. Therefore the above relations defi ne the one-zone-stability equations of state $S_{\rm dyn}$, $S_{\rm sec}$ and $S_{\rm vib}$. See Fig. 2 for a picture of $S_{\rm vib}$. Regions of secular instability are listed in Table 1.

3. Conclusions

Everything has a beginning and an end. That is the end of this sample paper. Have fun by writing your one!

Acknowledgements. Remove if proceeds: The European VLBI Network is a joint facility of European, Chinese, South African and other radio astronomy institutes funded by their national research councils. This research was supported by the European Commission's I3 Programme "RADIONET", under contract No. 505818.



Octaua 56

Longitudo et Latitudo ac Magnitudo stellarum fixarum

Fig. 2. Details of a star catalogue, from Ptolemy (1515).

References

Baker, N. 1966, in Stellar Evolution, ed. R. F. Stein,& A. G. W. Cameron (Plenum, New York) 333

Balluch, M. 1988, A&A, 200, 58

Cox, J. P. 1980, Theory of Stellar Pulsation (Princeton University Press, Princeton) 165

Cox, A. N.,& Stewart, J. N. 1969, Academia Nauk, Scientific Information 15, 1

Mizuno H. 1980, Prog. Theor. Phys., 64, 544

Ptolemy, C. 1515, Almagestum (Venice)

Tscharnuter W. M. 1987, A&A, 188, 55

Terlevich, R. 1992, in ASP Conf. Ser. 31, Relationships between Active Galactic Nuclei and Starburst Galaxies, ed. A. V. Filippenko, 13

Thomas, C. 1730, Mercurii philosophici firmamentum firmianum descriptionem et vum globi artificialis coelistis (Frankfurt, Leipzig)

Thompson, A. R., Moran, J. M. & Swenson, G. W. 1985, Interferometry and Synthesis in Radio Astronomy (John Wiley & Sons, New York)

Zheng, W., Davidsen, A. F., Tytler, D. & Kriss, G. A. 1997, preprint