# III
# Particle production

## 8 Particle spectra

### 8.1 A thermal particle source: a fireball at rest

The longitudinally scaling limit in production of hadrons, section 6.4, applies at the RHIC and at higher collision energies. At the SPS and AGS energy ranges, table 5.1, it is natural to explore the other reaction picture, the full-stopping limit. In this case all *matter* and *energy* available in the collision of two nuclei is dumped into a localized fireball of hot matter. Even at the highest SPS energies many experimental results suggest that such a reaction picture is more appropriate than the (1 + 1)-dimensional-flow picture.

The $m_\perp$ spectra we have seen in Fig. 1.7 on page 20 provide a strong encouragement to analyze the collision region in terms of the formation of a thermalized fireball of dense hadronic matter. The high slopes seen strongly suggest that the dynamic development in the transverse direction is very important. The pattern of similarity seen for very different particles is what would be expected to occur in hadronization of a nearly static fireball, and thus this case will be the first one we explore. However, we note that this is solely an academic exercise since SPS results provide ample evidence for rather rapid $v \simeq 0.5c$ transverse expansion. One can recognize this important physical phenomenon only once the properties of the stationary fireball matter are fully understood.

We consider a space–time-localized region of thermal hadronic matter acting as a source of particles, yielding naturally a Boltzmann spectral distribution. The thermal equilibrium is strictly a local property, with different temperatures possible in different space–time domains. The necessity that there is also a local thermal pressure implies that a fireball is in general a dynamically evolving object with local flows of matter, which we shall study further below. The virtue of this model is that the spectra



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