Particle acceleration in supernova remnant expanding inside wind-blown bubble

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We present our contribution about the determination of the **spectral softening** arising from the supernova remnant shock propagating through the **very hot shocked wind material** in **the core-collapse scenario**.

- **Background**: Evolution of **Core-collapse supernova remnants** (SNRs), inside the complex circumstellar medium (CSM), so-called **wind-blown bubble**, modified by massive stars subjects to the interactions of SNRs with CSM hydrodynamic structures and magnetic field. As consequence, particle acceleration and the emission from SNR should have been changed.
- **Methods**: We have considered a SNR with $60 M_{\odot}$ star progenitor as the star constructs a hot wind bubble in shocked wind region with **temperature above 10^8 K** to study **diffusive shock acceleration (DSA)** at **SNR forward shock**.
  Applied codes: Radiation Acceleration Transport Parallel Code (**RATPaC**) and **PLUTO** code to simultaneously solve the **cosmic-ray transport equation** in test-particle approximation, **hydrodynamic equations**, and **conduction equation for magnetic field** in 1-D spherical symmetry.
- **Results**:
  - The **sub-shock compression ratio for forward shock** diverges from **4 and reaches about 1.5** as **the sonic Mach number of forward shock decreases** during its evolution through **the hot material**.
  - When the forward shock interacts with the hot wind bubble, we have obtained **persistent softer particle spectra with spectral index close to 2.5** beyond free wind region between **the energy range 0.3GeV – 10TeV**.
  - **The CSM magnetic field has a significant impact on the emission morphology**.

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