PROBLEMI DI CINEMATICA RELATIVISTICA
TRATTI DI W.G. REES – PHYSICS BY EXAMPLE (Cambridge University Press)

Problema 52 : In un certo sistema di riferimento inerziale (SRI) sono emessi sue impulsi luminosi separati di **ΔL = 5 km** e **Δt = 5 μs**. Un osservatore in moto lungo la direzione che congiunge i due punti da cui sono emessi i due impulsi, con velocità relativa **v**, vede i due impulsi simultanei. Si trovi la velocità **v.**

Suggerimento Usare le trasformazioni di Lorentz

Problem 53

Observer A sees two events at the same place ($\Delta x = \Delta y = \Delta z = 0$) and separated in time by $\Delta t = 10^{-6}$ s. A second observer B sees them to be separated by $\Delta t' = 2 \times 10^{-6}$ s. What is the separation in space of the two events according to B? What is the speed of B relative to A?

Suggerimento Usare le trasformazioni di Lorentz
[Si può usare anche l'invarianza di Lorentz dell'intervallo spazio-temporale, ma non lo abbiamo ancora fatto]

Problem 55

A member of a colony on a moon of Jupiter is required to salute the UN flag at the same time as it is being done on Earth, at noon in New York. If observers in all inertial frames are to agree that he has performed his duty, for how long must he salute? (The distance from Earth to Jupiter is 8×10^8 km. The relative motion of the Earth and Jupiter's moon may be ignored.)

Suggerimento Usare le trasformazioni di Lorentz

Problem 56

Two rockets A and B depart from Earth at steady speeds of $0.6c$ in opposite directions, having synchronised clocks with each other and with Earth at departure. After one year as measured in Earth's reference frame, rocket B emits a light signal. At what times, in the reference frames of the Earth and of rockets A and B, does rocket A receive the signal?

Suggerimento Usare le trasformazioni di Lorentz tenendo conto che vi sono tre osservatori inerziali (con velocità relative +v e –v rispetto alla Terra per due di essi). Per i dati del problema può essere conveniente misurare le distanze in anni-luce e i tempi in anni, così c=1 e si semplificano alcune espressioni. Si ricordi poi di convertire in SI alla fine (se serve).

Problem 57

A very fast train of proper length L_0 rushes through a station which has a platform of length L ($< L_0$). What must be its speed v such that the back of the train is opposite one end of the platform at exactly the same instant as the front of the train is opposite the other end, according to an observer on the platform?

According to this observer, two porters standing at either end of the platform (distance L apart) kick the train simultaneously, thereby making dents in it. When the train stops, the dents are at a distance L_0 apart. How is the difference between L and L_0 explained by (a) the observer on the platform, and (b) an observer travelling in the train?

Suggerimento Provare, casomai si rifà in aula.

Problem 61

In its rest frame, a source emits light in a conical beam of width $\pm 45°$. In a frame moving towards the source at speed v, the beam width is $\pm 30°$. What is v?

Suggerimento Si può usare Lorentz, oppure le trasformazioni per v_x e v_y oppure usare solo la trasformazione per v_x e sfruttare (per mettere in relazione v_x con il modulo della velocità e dunque con v_y) il postulato della relatività speciale (c=costante in tutte le direzioni per tutti gli SRI).

Problem 58

Given two observers O and O', with O' moving at uniform velocity v in the positive x-direction relative to O, use the appropriate Lorentz transformations to show that if an object is moving with velocity component $u_{x'}$ in the frame of reference of O', then

$$u_x = \frac{u_{x'} + v}{1 + \frac{v u_{x'}}{c^2}},$$

where u_x is the corresponding velocity component according to O.

(a) A space ship is launched from Earth and maintains a uniform velocity of $0.900c$. The space ship subsequently launches a small rocket in the forward direction with a speed of $0.900c$ relative to the ship. What is the speed of the small rocket relative to the Earth?

(b) According to observations on the Earth, the nearest star to the solar system is 4.25 light years away. A space ship which leaves the Earth and travels at uniform velocity takes 4.25 years, according to ship-borne clocks, to reach the star. What is the speed of the space ship, expressed as a fraction of the speed of light c?