

## Geometrie der Erde und des Himmels

### Übung 1 (Elementare Kugelgeometrie)

1. a) Wo liegen alle Kugelpunkte, die von einem festen Kugelpunkt  $P$  denselben sphärischen Abstand  $\alpha$  haben? (Beispiele:  $\alpha = 60^\circ, 90^\circ, 120^\circ$ )  
 b) Wie gross ist der Radius  $\rho$  des entstandenen Kreises für  $\alpha = 60^\circ, 90^\circ, 120^\circ$ , beliebig? Für welchen Wert von  $\alpha$  ist  $\rho$  maximal?  
 c) Welche Zirkelöffnung ist nötig, um die Kreise für  $\alpha = 60^\circ$  und  $\alpha = 90^\circ$  auf einem Globus vom Radius  $r$  (z.B.  $r = 20\text{cm}$ ) einzuzichnen?
2. In der Figur ist  $P$  der Rechtspol des Grosskreises  $k$  durch  $A$  und  $B$ . Die Winkel  $\lambda = 120^\circ$  und  $\varphi = 30^\circ$  sowie der Radius  $r = 6370\text{ km}$  (Erdradius) seien gegeben.
 

- a) Berechnen Sie den sphärischen Abstand der Punktepaare  $(C, P)$ ,  $(D, P)$  und  $(A, B)$  im Längenmass.
  - b) Bestimmen Sie die Länge des Kleinkreisbogens  $\overset{\frown}{CD}$ , die Länge der Sehne  $CD$  sowie den sphärischen Abstand von  $C$  und  $D$ .


3. Wie viele Prozent der Kugeloberfläche umfasst ein Kugeldreieck mit
 

a)  $\alpha = \beta = \gamma = 90^\circ$ 
b)  $\alpha = 70^\circ, \beta = 80^\circ, \gamma = 120^\circ$ 
c)  $\alpha = \beta = \gamma = 135^\circ$
4. Unter dem **sphärischen Exzess**  $\varepsilon$  eines Eulerschen Kugeldreiecks mit den Winkeln  $\alpha, \beta, \gamma$  versteht man die Differenz  $\varepsilon = \alpha + \beta + \gamma - 180^\circ$ .  
 Zeigen Sie: Wird der sphärische Exzess  $\varepsilon$  im Bogenmass gemessen, so gilt für den Inhalt  $F$  der Dreiecksfläche  $F = r^2 \cdot \varepsilon$ . Was bedeutet also  $\varepsilon$ , wenn  $r = 1$  ist?
5. Wie viele Quadratkilometer misst auf der nördlichen Erdhalbkugel die Fläche zwischen dem Nullmeridian und dem Längengreis  $75^\circ \text{ W}$ ? (Erdradius  $6370\text{ km}$ )
6. **Polardreieck** (Figur 5)
  - a) Verifizieren Sie: Ist das Kugeldreieck  $A'B'C'$  Polardreieck zum Kugeldreieck  $ABC$ , so ist auch das Dreieck  $ABC$  Polardreieck zum Dreieck  $A'B'C'$ .
  - b) Zeigen Sie: Ist  $c = \overset{\frown}{AB}$  eine Seite eines Kugeldreiecks und  $\gamma'$  der Winkel in der entsprechenden Ecke  $C'$  des Polardreiecks, so gilt  $c + \gamma' = 180^\circ$ . Betrachten Sie dazu die Winkel in der Grosskreisebene durch  $A$  und  $B$ .
7.
  - a) Bei welchem Dreieck fallen Polardreieck und Gegendreieck zusammen?
  - b) Welche Eigenschaften hat das Polardreieck eines gleichschenkligen, eines gleichseitigen, eines rechtwinkligen Kugeldreiecks?
  - c) Berechnen Sie den Flächeninhalt des Polardreiecks zum Kugeldreieck  $ABC$  mit den Seiten  $a = 80^\circ, b = 100^\circ, c = 120^\circ$ .

# Elementare Kugelgeometrie

**JE Gale**



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